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With METALLURGICAL SUPPLEMENT.

The Engineer.

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The Engineer

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PUBLIC NOTICES

Assistant Engineers (7) REQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT for two tours of not less than 12 nor more than 18 months' service in the first instance. Subject to satisfactory service, the officers appointed will be eligible at the expiration of three years' service for confirmation in the permanent and pensionable establishment. Salary £480, rising to £920 a year. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, preferably between 25 and 30 years of age, unmarried, must have passed the examination for A.M.I.C.E., or possess a Degree in Engineering recognised by the Institution as exempting from parts A and B of the examination. They must have had proper technical training and preferably have had not less than two years' subsequent experience on large Engineering or Municipal Works. Candidates possessing other engineering qualifications may apply.—Applications should be made at once by letter, stating age, qualifications and experience, also whether married or single, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/14,485. 2460

Assistant Engineers (8) REQUIRED for the PUBLIC WORKS DEPARTMENT of the FEDERATED MALAY STATES for four years' service. Salary 400 dollars a month, rising to 600 dollars by annual increments of 25 dollars, plus a temporary non-pensionable allowance of 10 per cent. for bachelors and 20 per cent. for married men. The exchange value of the dollar in sterling is at present fixed by the Government at 2s. 4d., but its purchasing power in Malaya is considerably less than that of 2s. 4d. in the United Kingdom. No income tax at present imposed by the Federated Malay States Government. Free passages provided. Candidates, age 23 to 28, preferably unmarried, must have received a good theoretical training, preferably at a University or College recognised by the Institution of Civil Engineers and possess a Civil Engineering Degree or obtained such other diplomas or distinction in engineering as the Secretary of State may decide in any particular case, or have completed articles with a Civil Engineer of good standing and have passed the examination for Associate Membership of the Institution of Civil Engineers. In addition, candidates must have had at least one year's practical experience of civil engineering under a qualified civil engineer.—Apply at once by letter, giving brief details of qualifications and experience and stating age and whether married or single, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting clearly at head of application M/14378. 2326

Civil Service (Air MINISTRY). DESIGNERS AND DRAUGHTSMEN'S COMPETITION. A COMPETITION by interview will shortly be held for POSTS (pensionable under Civil Service conditions) for ENGINEERING DESIGNERS and DRAUGHTSMEN in the Air Ministry or at the Royal Aircraft Establishment, Farnborough, for Work on Aircraft Design and Calculations; Aero Engines, Design and Calculation; Perspective Sketches for Reproduction; Wireless and other Accessories; Ground Equipment and General Works Machinery and Plant. The scales of salary of the posts are :—

Designers, £250-15-£350 a year, plus Civil Service bonus.
Draughtsmen, Grade I., £160-10-£200 a year, plus Civil Service bonus.
Draughtsmen, Grade II., £125-7½-£150 a year, plus Civil Service bonus.

The competition will be open to (a) designers and draughtsmen serving at the Air Ministry or at the Royal Aircraft Establishment, and (b) other engineering designers and draughtsmen who have either served in H.M. Forces or served at sea and been awarded the British War Medal or the Mercantile Marine War Medal.

Candidates must have attained the age of 24, and (unless they are serving under the Air Ministry) must not have attained the age of 45 on 1st January, 1926.—Regulations and form of application may be obtained from THE SECRETARY, Air Ministry, S. 2 (Room 464), Austral House, Kingsway, W.C. 2, by whom the completed form of application must be received on or before 19th June, 1926. 2447

Civil Service Com- MISSION.
VACANCIES FOR CIVIL ENGINEERS IN CONNECTION WITH THE HYDRO-ELECTRICAL DEVELOPMENT OF THE RIVER SHANNON.

APPLICATIONS are INVITED from competent Civil Engineers for the following POSTS on the Civil Constructional Staff for the above scheme :—
TWO SENIOR ASSISTANT ENGINEERS.
Inclusive salary £500 per annum, with possible increases to £600 per annum.
Candidates must hold a degree of Civil Engineering or its equivalent.
The appointment will be made by the Minister for Industry and Commerce on the recommendation of the Civil Service Commissioners, who will investigate the qualifications of candidates with the assistance of a Board of Selection set up by the Commissioners. Applicants may be required to attend in person before the Board, and the successful candidates may be required to undergo a medical examination. A preference will be given to ex-National Army candidates.
Further particulars and forms of application may be obtained on a request in writing addressed to the SECRETARY, Civil Service Commission, 33, St. Stephen's Green, Dublin.
Completed forms of application will be received up to but not after the first post on June 11th, 1926. 2358

Civil Engineers (3) Re- QUIRED for the PUBLIC WORKS DEPARTMENT of NIGERIA for two tours of 12 to 18 months' service with prospect of extension. The posts are non-pensionable. Salary £800, rising by annual increments of £40 to £920 a year, plus an allowance of £72 a year whilst on duty in the Colony. Free passages and quarters and liberal leave on full salary. Candidates, aged 30 to 45, must be fully trained Civil Engineers and Surveyors, with previous experience of railway or road survey in the Tropics or elsewhere in undeveloped countries. Must have a thorough knowledge of location, setting out, and of the preparation of survey plans, and be able to estimate costs of formation work, and of bridging and culverting. Candidates, who are A.M.I.C.E., will be given preference.—Apply at once by letter, stating age, qualifications, and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/14234. 2471

PUBLIC NOTICES

Civil Engineers (5) Re- QUIRED for the PUBLIC WORKS DEPARTMENT of TANGANYIKA TERRITORY for a tour of 20 to 30 months' service with possible extension. Salary £400-£20-£500 a year, payable in the Territory in local currency, plus a temporary allowance of 20 per cent. at present authorised up to the 30th June, when it will be subject to review. Outfit allowance of £30 on first appointment. Free quarters and passages, and liberal leave on full salary. Candidates, aged 25 to 35, preferably unmarried, must have been regularly trained as Civil Engineers, and be Corporate Members of the Institution of Civil Engineers. Must be capable of levelling, surveying, measuring up work and preparing designs of bridges, &c. Must have had at least three years' experience under a qualified Civil Engineer on the construction of Harbour Works, Drainage Works, Water Supply, or other Public Works.—Apply at once by letter, stating age, qualifications, and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/14402. 2472

Department of Scientific AND INDUSTRIAL RESEARCH.
A JUNIOR ENGINEER is REQUIRED for the Forest Products Research Laboratory, South Farnborough, for work in connection with experimental timber drying kilns.
Candidates should have recently taken a good degree in engineering or possess equivalent qualifications.
Shop experience in steam engineering and aptitude for design are desirable.
Initial salary of the order of £250 per annum inclusive, according to qualifications.
Preference will be given, other things being equal, to ex-Service men.
Applications should be made on a form obtainable from the SECRETARY, Department of Scientific and Industrial Research, 16, Old Queen-street, S.W. 1, and must reach the Department not later than 12th June. 2435

Derby Technical College
APPLICATIONS are INVITED for the POST of PRINCIPAL. Commencing salary £800 per annum. Particulars from the undersigned.
F. C. SMITHARD,
Secretary to the Derby Education Committee.
Education Offices,
Becket-street, Derby.
May 3rd, 1926. 2342

PUBLIC NOTICES

City of Cardiff Education Com- MITTEE.
THE TECHNICAL COLLEGE.
Principal - CHARLES COLES, B.Sc. (Lond.),
The SERVICES will be REQUIRED in September next of a Full-time ASSISTANT LECTURER in ENGINEERING, qualified to teach up to Honours B.Sc. standard. The main subjects required will be those of Mechanical and Civil Engineering, but a good knowledge of Electrical Engineering will be a recommendation.
Salary payable according to Burnham Award.
Applications on foolscap paper, stating age, full qualifications, teaching and other experience, and giving copies of not more than three recent testimonials, should reach the Principal (from whom further particulars may be obtained) on or before Saturday, 5th June.
The successful candidate will be required to pass a medical examination by the Authority's Medical Examiner for Teachers at Cardiff before commencing duties, and to contribute under the Teachers (Superannuation) Act, 1925.
JOHN J. JACKSON,
Director of Education.
City Hall, Cardiff. 2375

Crystal Palace School of Prac- TICAL ENGINEERING.
Founded 1872.
MECHANICAL AND CIVIL ENGINEERING DIVISIONS.
PRESIDENT: J. W. WILSON, M.I.C.E., M.I.M.E.
PRINCIPAL: MAURICE WILSON, M.I.C.E.
Assisted by Staff of Lecturers and Instructors. Thorough, up-to-date Practical and Theoretical Instruction. Course completed in 2 years.
Students admitted at beginning of any term. 2240

Loughborough College.
DEPARTMENT OF MECHANICAL AND CIVIL ENGINEERING.
The Governors invite APPLICATIONS for the POST of ASSISTANT in the above Department.
Salary in accordance with the Burnham Scale. Extra remuneration according to the College Scale will be given if evening lecturing is taken, although this is quite optional.
Full particulars of the appointment and forms of application can be obtained from the REGISTRAR, to whom applications should be forwarded not later than the 22nd May. 2348

PUBLIC NOTICES

Administrative County of LONDON.
The London County Council invites APPLICATIONS for the POSITION of PRINCIPAL of the L.C.C. SCHOOL of ENGINEERING and NAVIGATION, High-street, Poplar, which will be vacant on 1st October. This Institute comprises a day navigation department, a day marine engineering department, a junior technical day school in engineering and navigation, and evening classes in mechanical and electrical engineering. The Institute is situated near the East and West India Docks.
Salary scale, £820 by £50 to £960. The qualifications required will be suitable technical and academic distinctions, technical experience and administrative and organising ability. Preference will be given, other qualifications being equal, to those who served or attempted to serve with the Forces of the Crown.
Apply Education Officer (T.1.a.), The County Hall, Westminster Bridge, S.E. 1 (stamped addressed foolscap envelope), for form to be returned by 30th June, 1926.
Canvassing disqualifies.
MONTAGU H. COX,
2461 Clerk of the London County Council.

Munitions Committee Research FELLOWSHIPS.
The Faculty of Engineering of the University of Liverpool will shortly proceed to APPOINT TWO POST-GRADUATE RESEARCH FELLOWS, and INVITE APPLICATIONS from Graduates in Engineering of the University engaged in industry or research. The value of the Fellowship is £250 for the first year and the appointment may be renewed for a second year at £350.
Applications should be made to the DEAN before June 15th, with a statement of qualifications and experience, and an outline, which will be regarded as confidential, of the problem it is proposed to investigate. 2455

Northampton Polytechnic INSTITUTE,
ST. JOHN-STREET, E.C. 1.
APPLICATIONS are INVITED for the POST of LECTURER in MATHEMATICS. The Lecturer appointed will be required, in addition to actual class teaching and associated duties, to organise and supervise the teaching of the subject in connection with all courses, day and evening, into which it enters. Salary according to Burnham scale, together with an allowance according to qualifications and experience not exceeding £96. Applications should be submitted by June 26th.—Further particulars and forms of application may be had from the PRINCIPAL. 2439

University of London.
The Senate invite APPLICATIONS for the UNIVERSITY READERSHIP in MECHANICAL ENGINEERING, tenable at King's College. Salary, £500 a year.—Application (12 copies) must be received not later than first post on 17th June, 1926, by the ACADEMIC REGISTRAR, University of London, South Kensington, London, S.W. 7, from whom further particulars may be obtained. 2448

University College of South WALES AND MONMOUTHSHIRE.
COLEG PRIFATHROFAOL DEHEUDIR CYMRU A MYNWY.
The Council of the College invites APPLICATIONS for the APPOINTMENT of ASSISTANT LECTURER and DEMONSTRATOR in ENGINEERING. The commencing salary will be £300 per annum.
Further particulars may be obtained from the undersigned, by whom three copies of application and testimonials must be received on or before June 14th, 1926.
D. J. A. BROWN,
Registrar.
University College,
Cardiff.
May 25th, 1926. 2464

Belper Urban District Council. WATERWORKS EXTENSION.
The Belper Urban Council invite TENDERS from experienced firms of Boring Contractors for PUTTING DOWN a 24in. BORE-HOLE at their Waterworks at Belper to the depth of 175ft. and LINING with STEEL TUBES.
Copies of the specification may be obtained from the Council's Consulting Engineers, Messrs. G. and F. W. Hodson, Bank Chambers, Loughborough, on deposit of cheque for Five Guineas, which will be refunded to bona fide tenderers on return of the papers.
Tenders are to be sent to the undersigned not later than 12th June, 1926.
The lowest or any Tender not necessarily accepted.
Dated this 17th day of May, 1926.
J. PERCY E. PYM,
Clerk to the Council.
Council Offices, Belper. 2403

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PUBLIC NOTICES

Borough of Ryde.

DISPOSAL OF PLANT.

The above Council invite OFFERS for the undermentioned PLANT, which can be inspected at the Corporation Waterworks, Knighton, near Newchurch, I.W., by arrangement with the undersigned :—

(1) One 12 H.P. Portable Engine, Davey, Paxman, 1918, first-class condition.
(2) One 14 H.P. Portable Engine, Garrett and Sons, 1924, as new.
(3) Two 8in. by 8in. Double-cylinder Steam Winding Winches, good condition.
(4) One Complete Hardy Type A Air Compressing Set and Four Hammer Drills and Accessories, first-class condition.
(5) Three Engine Belts.
(6) 500 Yards Lineal "Jubilee" Rail Track, 24in. gauge in 16ft. 6in. lengths.
(7) Four Sets of Points and One Turntable.
(8) Four Tipping Wagons.
(9) Three Tipping Skips.

Sealed Offers, endorsed "Plant," are to be delivered to me not later than Twelve o'clock midday on Tuesday, the 25th May, 1926.

The Council do not bind themselves to accept the highest or any Tender.

B. F. HOLNESS, M. Inst. M. and Cr. E.,
Borough Engineer.

Town Hall, Ryde, I.W.,
30th April, 1926. 2352

Borough of Saltash.

TO SHIPBUILDERS AND OTHERS.

The Saltash Corporation invite TENDERS for the CONSTRUCTION of a STEAM FERRY BRIDGE in accordance with plans and specification, which may be obtained from the undersigned upon request, accompanied with a deposit of £2 2s., which will be returned upon receipt of a bona fide Tender. Sealed Tenders, marked "Ferry Bridge," to be sent to the undersigned, together with the plans and specification, by the 30th June, 1926. The lowest or any Tender not necessarily accepted.

FRED. ET. CLEVERTON,
Town Clerk, Saltash.

22nd May 1926. 2431

City of Bradford.

SEWAGE DEPARTMENT.
SURPLUS PLANT FOR DISPOSAL.

ONE "Ruston" No. 15 STEAM CRANE NAVVY, 2 c.y. bucket, 4ft. 8½in. gauge.
50 (about) "Hudson's" 20 c.ft., 2ft. gauge, "U" shape TIPPING WAGONS.
3 OPEN-TOP PRESSED STEEL TANKS, 140ft. by 48ft. by 12ft. high.
One 50 B.H.P. SEMI-DIESEL OIL ENGINE, by Robson.
One 10/20 H.P. "Titan" TRACTOR, by the International Harvester Corporation, Chicago.

The above Plant has been little used, and is in excellent condition, and may be inspected at the Esholt Sewage Disposal Works (station, Apperley Bridge and Rawdon, L.M. & S.).

Further particulars may be obtained from, and offers to be submitted to, the SEWAGE WORKS ENGINEER, Esholt Hall, near Shipley.

10th May, 1926. 2367

City of Birmingham Water DEPARTMENT.

The Water Committee of the Corporation of the City of Birmingham is prepared to receive TENDERS from competent firms for the MANUFACTURE and DELIVERY of 62in. diameter SOCKET and SPIGOT STEEL PIPES lined centrifugally with concrete, together with the necessary SPECIALS, for portions of the Third Main on the Elan Aqueduct situated (Contract 18, about 1900 lineal yards) on the Severn Siphon between Hagley and Kidderminster, and (Contract 19, about 1700 lineal yards) on the Downton Siphon in the neighbourhood of Knighton.

Specifications and forms of Tender may be obtained from the Secretary of the Water Department, Council House, Edmund-street, Birmingham, on payment of the sum of One Guinea in respect of each of the two proposed contracts. The amount deposited will be refunded on receipt of a bona fide Tender.

Sealed Tenders, on the forms provided for the purpose, addressed to "The Secretary, Water Department, Council House, Birmingham," and endorsed "Contracts 18 and 19, Steel Pipes," should be delivered at the Secretary's office on or before 10 a.m. on Thursday, 10th June, 1926.

The Water Committee does not bind itself to accept the lowest or any Tender.

F. W. MACAULAY, M. Inst. C.E.,
Chief Engineer.
J. H. BROADLEY, F.C.I.S.,
Secretary.

Water Department,
Council House, Birmingham,
13th May, 1926. 2419

City of Hull.

TO STEEL ROOF BUILDERS.
ST. PAUL'S-STREET BATHS AND WASH-HOUSES.

The Corporation is prepared to receive TENDERS for STEEL ROOF PRINCIPALS and other STRUCTURAL WORK, amounting altogether to about 23 tons.

Forms of Tender, specification, and quantities may be obtained of the undersigned on payment of £1, returnable to firms submitting a bona fide Tender.

Specification, quantities, and plans of the contract plans can be obtained after the 1st June on payment of 5s., not returnable. Remittances must be made payable to Mr. F. Steadman, City Treasurer, Guildhall, Hull.

Tenders, endorsed "Tender for Steel Roofs, St. Paul's-street Baths," are to be addressed to the Chairman of the Baths Committee and delivered at the Town Clerk's Office, Hull, before Noon on Friday, the 18th June.

The Corporation does not bind itself to accept the lowest or any Tender.

By Order,
F. W. BRICKNELL,
City Engineer.

Guildhall, Hull,
20th May, 1926. 2145

Napier Harbour Board (New ZEALAND).

RESIDENT ENGINEERSHIP.

APPLICATIONS are INVITED for the above POSITION.

Salary £1250 per annum.

Canvassing members of the Napier Harbour Board will disqualify applicants.

Applications to be addressed to the SECRETARY of the NAPIER HARBOUR BOARD and delivered at the Harbour Board Office, Napier, New Zealand, not later than Monday, October 11th, 1926.

A copy of the conditions can be obtained from the Board's London Agents, Messrs. W. and A McArthur, Ltd., 18/19, Silk-street, Cripplegate, London, E.C. 2. 2415

The Borough of Portsmouth WATERWORKS COMPANY.

APPOINTMENT OF ASSISTANT ENGINEER TO THE COMPANY.

APPLICATIONS are INVITED for the APPOINTMENT, now vacant, of ASSISTANT ENGINEER to the Company. Candidates should be between 35 and 40 years of age and Corporate Members of the Institution of Civil Engineers would have preference.

Applications will be considered only from those who have had a full training (theoretical and practical) and a first-class experience in the design, construction, maintenance, and administration of waterworks. Knowledge of pumping machinery would also be advantageous. Commencing salary £500 per annum, rising by annual instalments of £25 to £650, less 5 per cent. obligatory contribution to the Company's Superannuation Fund.

The appointment is subject to the selected candidate satisfactorily passing an examination by the Company's Medical Officer, and may be determined after three months' notice on either side. Application should be made only on the forms which will be provided on request by the ENGINEER, Waterworks Offices, Commercial-road, Portsmouth, and must be delivered at that address as soon as possible, but not later than Friday, June 4th, 1926. 2375

PUBLIC NOTICES

The Madras and Southern MAHRATTA RAILWAY COMPANY, Limited,

25, Buckingham Palace-road, Westminster, S.W. 1, invite TENDERS for :—

50,000 STEEL PALES FOR FENCING.

Tenders are due in on 15th June, 1926, by 2 p.m. Tender form obtainable at above address, fee One Guinea, which is not returnable.

The Directors do not bind themselves to accept the lowest or any Tender. 2432

City of Wakefield Waterworks.

EYBURN SCHEME.
CONTRACT NO. 6.—FILTER HOUSE.

The Corporation invite TENDERS for the CONSTRUCTION of a FILTER HOUSE, about 130ft. by 47ft., and FOUNDATIONS for PLANT, TANKS and incidental WORK, at Jaw Hill, Kirkhamgate, near Wakefield.

Forms of Tender, conditions of contract, specification, quantities, and other particulars may be obtained from, and drawings may be seen at, the office of Mr. C. Clemesha Smith, M. Inst. C.E., Waterworks Engineer, Town Hall, Wakefield, on and after Tuesday, the 1st June, 1926, on payment of a deposit of One Guinea, which will be returned on receipt of a bona fide Tender and the documents supplied.

The Corporation do not bind themselves to accept the lowest or any Tender.

Tenders, endorsed "Filter House," to be delivered to the TOWN CLERK, Town Hall, Wakefield, not later than Noon on Monday, 14th June, 1926. 2433

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS UNLESS SPECIFICALLY REQUESTED.

WANTED, a Fully Qualified SHOP ENGINEER, who is capable of the Design of Special Duty Machines for the Manufacture of Heavy Motor Car Parts.—Address, 2451, The Engineer Office. 2451 A

WANTED by a Large Motor Manufacturing Firm in the Midlands, trained ENGINEER, with thorough knowledge of Modern Design and Production Methods, to assist in Works Management. Full particulars, stating age, education and experience.—Address, 2469, The Engineer Office. 2469 A

CIVIL ENGINEER of Wide Experience or BUSINESS MAN who has managed similar undertaking WANTED by large Contracting Company to Take Charge of Headquarters Organisation. Applicants will be required to give proof of ability to organise and to conduct undertaking on modern commercial lines. Salary of not under £2000 will be paid.—Write in first instance to "N. E.," c/o Street's, 6, Gracechurch-street, E.C. 3. 2434 A

CIVIL ENGINEERS.—REQUIRED for Important railway in the Argentine, TWO ASSISTANT ENGINEERS (Assoc. M. Inst. C.E. or equivalent), with railway experience. Salary, £600/700, according to qualifications. Applicants to give age, qualifications with full details of experience. &c.—Apply by letter to "Y.T.," c.o. Street's, 6, Gracechurch-street, London, E.C. 3. 2456 A

CONSULTING ENGINEER and MANUFACTURER has an OPENING in his London Office for a PREMIUM PUPIL. Must have a good general education, some knowledge of drawing an advantage. Would be given a thorough training with a view to a permanent post when proficient. Interview by appointment.—Address, 1986, The Engineer Office. 2013 A

ENGINEER REQUIRED for DESIGN of all classes of Modern Material Handling Plant. State salary required and qualifications.——Address, 2478, The Engineer Office. 2478 A

JUNIOR CIVIL ENGINEERING ASSISTANT REQUIRED TEMPORARILY (probably two years) for a water company in Kent. One with some Ferro-concrete Experience preferred.—Write, stating experience and salary required, 2470, The Engineer Office. 2470 A

LONDON OFFICE.—A COMPANY Building Marine and Stationary Oil and Petrol Engines REQUIRE the SERVICES of a SALES ENGINEER with suitable connection and experience in these lines. Salary and commission. State age, references, and remuneration.—Address, 2441, The Engineer Office. 2441 A

MECHANICAL ENGINEER REQUIRED as ACTIVE DIRECTOR on established company making regular profits. Investment £5000, fully secured by debenture convertible into shares. Salary £520 p.a. and interest on capital. Open to solicitors' and accountants' investigation.—Write, Box 452, Pool's, 180, Fleet-street, E.C. 4. 2454 A

OIL ENGINE SALESMAN, Experienced, Capable of taking charge of the Oil Engine Department of a leading Firm of Manufacturers. Applicants should be of good address, have a good technical education and a knowledge of Oil Engines based on experience in the shops and outside; fully capable of preparing tenders and specifications for land and marine services, a connection with these services is essential. Those who cannot fulfil the above requirements need not apply. Applicants to give full particulars.—Address, 2481, The Engineer Office. 2481 A

POWER STATION SHIFT ENGINEERS.—TWO ASSISTANT ELECTRICAL ENGINEERS REQUIRED by large Company for service in the East. Must have had previous power station experience with Water-tube Boilers, High-speed Engines and Turbines and Switchboard operation. Age 23-30, single. Three years' agreement. Free passage out and home, free furnished quarters. Salary £450 per annum.—Write, giving full particulars and copies of testimonials, to Box "T.," c/o The Regent Advertising Service, Ltd., 165-167, Moorgate, E.C. 2. 2440 A

REQUIRED for Service in India, a COSTING CLERK, accustomed to getting out the Costs of Railway Wagons, &c. Applicants should state experience and salary expected. Age not to exceed 35 years.—Address, 2467, The Engineer Office. 2467 A

REFRIGERATING ENGINEER SALESMAN WANTED. Progressive position to capable man. Age 27/35. State age, experience, salary.—Address, 2442, The Engineer Office. 2442 A

SALES REFRIGERATING ENGINEER, with experience and connection with large Cold Storage and Shipping Concerns.—Write, stating age, experience, education, salary, 2450, The Engineer Office. 2450 A

THE SERVICES of a GENTLEMAN are REQUIRED by a well-known engineering firm, holding valuable connection in the East; age about 30; must be of good address and social standing, to make an extensive tour of the F.M.S. in connection with the Rubber industry. Mechanical engineering training, coupled with sound commercial knowledge and selling ability, essential. Full qualifications invited in strict confidence.—Address, 2473, The Engineer Office. 2473 A

WANTED IMMEDIATELY, TWO First-rate DRAUGHTSMEN, accustomed to General Layout Work and Detail Designs on Commercial and Passenger-carrying Vehicles.—Address, stating age, full particulars of qualifications and wages required, 2443, The Engineer Office. 2443 A

CONSTRUCTIONAL ENGINEERS, London, REQUIRE DRAUGHTSMAN to Design Steel Buildings, &c.—Apply by letter, giving age, experience and salary required, to Box No. 280, Hannaford and Goodman, Ltd., 57/59, Ludgate-hill, London, E.C. 4. 2153 A

SITUATIONS OPEN (continued)

DRAUGHTSMAN to Take Charge of London Structural Engineers' Office; must be expert Designer of Light Steel Buildings.—State experience, age and salary required, in confidence, Box No. 60, Hannaford and Goodman, Ltd., 57/59, Ludgate-hill, E.C. 4. 2459 A

ENGINEER DRAUGHTSMAN REQUIRED to undertake Lay-out and Design of Industrial Buildings and Sidings; man with Public Works Experience preferred. Applicant should be capable of using the engineers' instruments and of estimating and taking out quantities.—Apply, PEARSON and DORMAN LONG, 19, Victoria-street, Westminster, S.W. 1 (mark letter "E.D."). 2465 A

MACHINE TOOL DRAUGHTSMAN REQUIRED for special machine designing. Applications are only invited from men of first-class ability. Please reply fully, stating experience.—Address, 2269, The Engineer Office. 2269 A

MECHANICAL DRAUGHTSMAN, Age About 24, preferably Locomotive experience.—Apply, stating experience and salary required, to "SENTINEL" WAGGON WORKS, Ltd., Shrewsbury. 2444 A

SENIOR DRAUGHTSMAN REQUIRED, Thoroughly experienced in Design of Modern Steam Road Rollers. State age, experience, and salary required.—Address, 2479, The Engineer Office. 2479 A

PRACTICAL WORKS FOREMAN REQUIRED, with up-to-date general shop experience, for reducing costs and speeding up output. None but live men need apply. London district.—Address full particulars, salary required, 2475, The Engineer Office. 2475 A

MECHANICS, FITTERS and ENGINEERS, Desiring more congenial and lucrative employment, should write for particulars of my intensive course in draughtsmanship. There is an increasing demand for qualified draughtsmen and you can learn this interesting profession while you are earning. Postal or private tuition by arrangement.—PERCY PITMAN, M.I. Mech. E., 25, Victoria-street, Westminster, S.W.1. 2007 A

SITUATIONS WANTED

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For continuation of Small Advertisements see page 3.

A Seven-Day Journal

The Coal Dispute.

SHORTLY after the publication of the report of the Royal Commission on the Coal Industry, the Government intimated that it would accept the recommendations advanced by the Commissioners, provided the coalowners and the miners would do likewise. There were recommendations in the report which were not altogether to its liking, but it was prepared to accept them if by so doing a general settlement could be reached. During the past week-end the situation has materially changed. Mr. Baldwin's proposals, advanced immediately after the general strike had been declared at an end, were, in turn, rejected by the men and the employers. In strongly worded letters to both parties, the Prime Minister, replying to the notices of rejection, made it clear that the Government had regained its freedom for all purposes, and no longer considered itself bound by the terms of its offer. Its willingness to accept the recommendations of the Coal Commission's report is therefore not to be regarded as still in force. As regards the additional subsidy of £3,000,000, which it was part of the Government's post-strike scheme to afford to the industry, the Prime Minister in his letter to the Miners' Federation stated that the offer would remain open until Monday of next week, May 31st, but that it could not be maintained beyond that date, in view of the great burden thrown on the national finances by the general strike and the continued coal stoppage. To the miners, Mr. Baldwin expressed his regret that they had not submitted any practical proposals regarding alterations of wages or hours, and stated that so long as that attitude were maintained he could not see any useful purpose that would be served by meeting representatives of the men. To the owners he wrote greatly regretting their uncompromising attitude. Regarding their complaint that many of the present troubles of the industry had been caused by "political interference," he replied that such interference had been produced by the incapacity of the industry, unlike others, to settle its disputes for itself.

Reinstatement on the Railways.

TOWARDS the end of last week there were, it was reported, something like 200,000 railway men who had not been reinstated in their former employment after their illegal defection on May 4th. The railway companies explained that they would be delighted to be in a position to take back all their employees, but that present circumstances made such a course impossible. The coal industry dispute and its effect on other large industries had reduced the traffic on the railways, and, in addition, in order to economise the reserves of coal, it was essential to reduce the passenger services. These factors inevitably resulted in tens of thousands of men being thrown out of work. The situation at one time looked gloomy, and among certain sections of the railwaymen there was some talk of a renewed strike in order to force the companies to reinstate all their men. Happily, any such folly has been averted, for the time being at all events, by an agreement reached on Friday, May 21st, between the railway companies and the representatives of the three railway unions. It was arranged that the "guaranteed week" agreement should be suspended in order that the work available should be spread over a larger number of men working shorter hours. The unions have hitherto always opposed any attempted interference with the guaranteed week, but faced with the fact that the large number of men out of work are not entitled to unemployment benefit and have to be supported from the dwindling union funds, they consented to the agreement being placed in abeyance.

The Transport of Coal.

WHILE the transport and railway workers' unions have been busily engaged solving the problems involved in the reinstatement of their members, they have apparently had no time to consider the position in which the general strike has left the coal miners. At the end of last week the Miners' Federation addressed an appeal to the Transport and General Workers' Union and to the three railway unions, asking them to assist the miners by not handling coal stacked in sidings or at the docks. It was a very mildly worded appeal, and so far appears to have elicited no response. Actually, coal supplies are now being carried satisfactorily by the various railway companies, and no instructions, it is stated, are likely to be issued by the railway unions to their members ordering them not to handle it. To issue such instructions would, it is held, be difficult for the unions in view of the agreement entered into with the companies immediately after the general strike ended. The supplies of coal at the pitheads are reported to be generally of no great extent. The coal now being moved is principally being drawn from the railway sidings and depôts. Not only are the miners deprived of the assistance of the railway unions in the matter of the handling of coal; they are also compelled to forego the financial help which in previous disputes they have received from the railwaymen, whose finances have been heavily depleted as a result of the general strike. The folly of the general strike is daily becoming more apparent, even to those who willingly or otherwise bear a large measure of responsibility for its declaration. It did nothing, as Mr. Baldwin says, to strengthen the hands of the miners or improve their position, and it is really incomprehensible how any body of men could have believed that they would assist the miners by holding up the industries of the country, increasing unemployment, and threatening to cut off the nation's food supplies.

Electricity in Ireland.

IN an important report just presented to the Government of Northern Ireland by the Development Commission, the extended use of electrical power in industry is considered. The Commissioners have come to the conclusion that whilst the existing general trade depression and financial stringency may tend, for the present, to delay the more general use of electrical power, it is probable that a revival of trade, coupled with the desire to reduce the costs of production, will result in increased development in the application of electrical power in the future. Expansion along these lines would, it is considered, be beneficial to the general community. The cost of transporting and distributing coal for industrial and domestic purposes would be greatly reduced and wastage in the present methods of utilising coal would be eliminated. Railway electrification would do much to assure the economic and technical success of a comprehensive power scheme in Northern Ireland, and the Commissioners express the hope that the Ulster Government will make every endeavour to encourage the railway companies to co-operate in such a scheme. The Commission's main recommendations include the granting of power to the Electricity Commissioners to refuse their consent to schemes which would render the proposed undertakings unable to participate at some future date in a comprehensive scheme of electricity supply. The geographical conditions are said to be suitable for schemes of short-distance railway electrification, and the demands likely to result from such schemes would ensure the economic success of a comprehensive system of electricity supply. Another recommendation is that the Government should assist in raising the necessary capital by guaranteeing a rate of interest for a specified number of years or by an advance or loan at low rates of interest, or without interest for a certain period.

London County Council Tramways.

THE approximate results for the working of the London County Council Tramways for the year ending March 31st last, and the estimated results for the current year, were recently made public. It appears that the estimated net deficiency for the past year is £192,582, but that figure does not take into account the fact that, whereas the total provision for repayment of debt should have been about £439,000, the actual amount set aside for that purpose was, by consent of the Treasury, only £139,937. Had the full amount been repaid the deficiency would have reached £491,645—nearly half a million sterling. The estimated deficiency for the year ending March 31st next is, according to the Highways Committee of the Council, £127,330, and it is based on the assumption that the total receipts will average 15·03d. per car mile. As the receipts per car mile during the last two years have been 14·63d. and 14·61d., and as the receipts have fallen every year for the last five years, it is difficult to understand why a higher figure should be looked for during the present year, so that, quite possibly, the deficiency may be considerably larger than £127,330. But supposing the anticipation to be correct, the estimate is again based on the assumption that a lessened provision for the repayment of debt will be made. Taking the amount remitted to be approximately the same as during the past year—say, £300,000—the true deficiency will approximate £430,000. In other words, the loss on two years' working will be over £920,000.

Some Telephone Figures.

SOME interesting and curious telephone statistics were given last week in an address delivered at Glasgow by Mr. A. E. Coombs, district manager of the Post Office Telephone Department. Mr. Coombs argued that the rise and fall in telephone traffic coincided with fluctuations of trade and with waves of optimism and pessimism in business. In 1925, as compared with 1924, the number of telephones in use in the United Kingdom increased by 114,287 and the number of calls by subscribers rose by as much as 94 millions. The figures for 1926 implied that during the first quarter of this year the progress had not only been maintained, but had accelerated. In 1925 the estimated number of calls made in Great Britain was eleven hundred million, or about 3½ million for every normal weekday. During the rush hour between 10 a.m. and 11 a.m. one-sixth of the day's total number of calls was usually dealt with. Judging from experience in the Glasgow district, it would seem that of the calls originated 85 per cent. were completed at once, 10 per cent. were delayed or lost through the required number being engaged, 2·5 per cent. were ineffective because no reply could be obtained from the subscriber called, 1 per cent. were lost because of wrong numbers being given, and about 0·5 per cent. because junctions were engaged. The "number-engaged" trouble represented in a year all over the country an estimated loss of £17,500. Last year, Mr. Coombs concluded, the Department received one letter of complaint for every 28,000 calls. This year so far the proportion was one letter to every 30,000 calls.

The Late Mr. Frederick S. Spiers.

BY the death of Mr. Frederick S. Spiers, on the 21st, science loses one who was well known, particularly in the realm of physical chemistry, for his ability as an organiser. Mr. Spiers was born in London on October 21st, 1875. He was educated at the Central Foundation School, Finsbury Technical College, and at the Central Technical College, South Kensington, and later obtained the degree of B.Sc. (London) and the Diploma of Associate of the City and Guilds Institute. He is best known for his work as secretary and editor to the Faraday Society, which he assisted to found in 1902. With his help the Society has grown from very small beginnings to being the initiator of some of the most important scientific discussions in the country. In 1920 he added to his work that of secretary to the newly founded Institute of Physics, and he showed a like activity in this post. During the war he stimulated the foundation of a Nitrogen Products Committee of the Faraday Society and organised for the British Science Guild the successful exhibitions of British scientific products held in 1917 and 1918.

The Destiny of Technical Education.

IN his presidential address on the 24th to the Association of Teachers in Technical Institutions, Mr. A. E. Evans, dealing with the nature of education in general and the relationship between what are called cultural and vocational education, had much to say in agreement with views which we ourselves have expressed in the past. Intellectual snobbery and make-believe, Mr. Evans remarked, characterised those who regarded art, literature, music and the classics as the members of an aristocratic educational family, of which science was a distant cousin and technology and commerce illegitimate descendants. The "humanities," he claimed, were not the monopoly of the ancient languages or of modern literature. Engineering, chemistry, building and commerce, when taught in the right way, possessed equal humanitarian value. Training for citizenship and character could, he maintained, be carried out as effectively by a technical teacher as by any other. The subjects taught on the vocational side in technical schools and colleges teemed with examples of how service to humanity had been rendered by their help, examples as fine as any to be found in the records of Greek and Roman literature. Education was not an end in itself. It must have both a livelihood and a leisure aspect. The vocational and cultural sides were of equal moment, and no educational system would fulfil its essential purpose unless both were present. A blind insistence on so-called cultural education with a stubborn refusal to admit the existence of the other side would lead to chaos. With the setting up of an inquiry, under the chairmanship of Lord Emmott, to determine the relationship between technical and other forms of education and between technical education and commerce, the time, Mr. Evans held, had not yet arrived when the Association could rest from its labours. It was necessary for it to ensure that the external opinion on the subject which at last had been aroused should be guided along proper channels, and not allowed to depart, as there were signs of its doing, from the direction originally given to it.

A New Atlantic Cable.

ON Tuesday, May 25th, the Western Union Telegraph Company made a start on the laying of its new Transatlantic cable from Bay Roberts, Newfoundland, to Sennen Cove, Cornwall. After a day's delay, owing to unfavourable weather conditions, the shore end of the cable, which is about 6 miles long, was landed at the latter point, which the cable ship Colonia is to link up with the oceanic span of the cable. Returning to England, the Colonia will re-load with the final section of the cable which is to be laid between Newfoundland and New York. The new cable is the first of its kind linked up to this country, and will be capable of transmitting 2500 letters a minute. The cable has been designed by the engineers of the Western Electric Company, in conjunction with the Western Union Telegraph Company and the Telegraph Construction and Maintenance Company. The inductive loading, by means of which the greatly increased speed of transmission will be made possible, consists of a thin layer or wrapping of "permalloy," which is an alloy of about 78 per cent. nickel and 22 per cent. iron, and has a very high permeability at low magnetising forces. The proposal to use this alloy in the form of a wrapping surrounding the copper conductor was made by Mr. Buckley soon after the war.

Electric Train Testing on the Metropolitan Railway.

By GEORGE HALLY, C.M.E., Metropolitan Railway.

No. II.*

Train.

Fig. 4 shows one of the Metropolitan trains upon which a series of tests was recently carried out. At each end of the train is a motor car propelled by four British Westinghouse motors, each developing 200 horse-power—one-hour rating and 75 deg. Cent. temperature rise. The control gear is of the electric pneumatic type arranged for multiple operation of the motor cars. The train is fitted with Westinghouse brakes, automatic couplings and central buffing gear. There are five third-class and two first-class cars in the train, providing seating accommodation for 322 passengers. The weight of each motor car is 44 tons and of each trailer car 22 tons, so that the total weight of the vehicles is 198 tons. The train is shown standing outside the Neasden works, and on the extreme right of the photograph will be noticed one of the semaphore signals for the "down" fast line. On the extreme left of the photograph will be seen one of the fog repeaters used when conditions prevent the lights in the other signals being seen by the motormen.

Car.

Fig. 7 shows more clearly the car in which the testing instruments were installed. It will be observed that there is a driver's compartment, a luggage compartment, and a passenger space. In order to interfere as little as possible with the comfort of the travelling public the compartment on the left-hand side of the centre doors was used for testing purposes, entrance and exit being gained by the testing staff through the door in the luggage compartment. A temporary partition was put into place at the point indicated by the arrow, and the compartment thus obtained involved the loss of only twenty-two seats for passenger-carrying purposes. In this way complete privacy was ensured for the testing staff—a most necessary consideration, as the public is found to take an embarrassing interest in any unusual event on the railway. In passing it may be mentioned that when the train is standing at a terminal station and travellers have an opportunity of viewing the testing gear through the side windows of the compartment, it is held by the majority that some form of broadcasting is being undertaken.

* No. I. appeared May 21st.

Car Interior.

Fig. 5 shows the inside of the car with all the testing gear in position. In the centre of the engraving will be seen the temporary partition held in place by four wooden clips and fitted at the top with two chute ventilators. On the right and left-hand sides of the partition will be noticed two clear windows, which are blanked off when tests are being carried out. In front of the partition is a movable table, on the centre of which rests the traction recorder already described.

There is a point of special interest in connection with the placing of the traction recorder in the position shown in the engraving. The makers of the instrument—Messrs. Evershed and Vignoles—suggested that if it were placed with its pens working in the direction in which the train was travelling the chart lines would be steadier, as the oscillations of the car would not affect them. It is found, however, that by placing the instrument across the car as shown in the engraving the oscillations are most marked at certain points of the line, and by comparing different charts taken on the same piece of road the parts of the line which require attention from the permanent way engineers can be readily picked out. As the distance between two stations a mile apart is represented by 9in. of chart it is possible by noting the excessive vibrations in the chart to determine to within a few feet the rough parts of the line. There is thus unexpectedly provided a record of the greatest value which shows not only any defect in the springing of the cars, but also in the condition of the permanent way.

On the left-hand side of the recorder will be seen the device for operating the brake application recording pen with a gauge to indicate the amount of reduction in the train pipe, and in front will be seen a leather-covered pad which is used as a hand rest when writing on the charts. To the right of the recorder is a tumbler switch which operates the start and stop recorder pen, the observer sitting on one of the side seats not shown in the engraving. Above the recorder in the centre of the partition are the two main fuses and also a switch marked "up" road and "down" road. This switch is introduced into the leads coming from the speed transmitter on the trailer car and is closed in the position to suit the direction of travel of the train. On the right-hand side of the partition is the wheel diameter corrector, and the

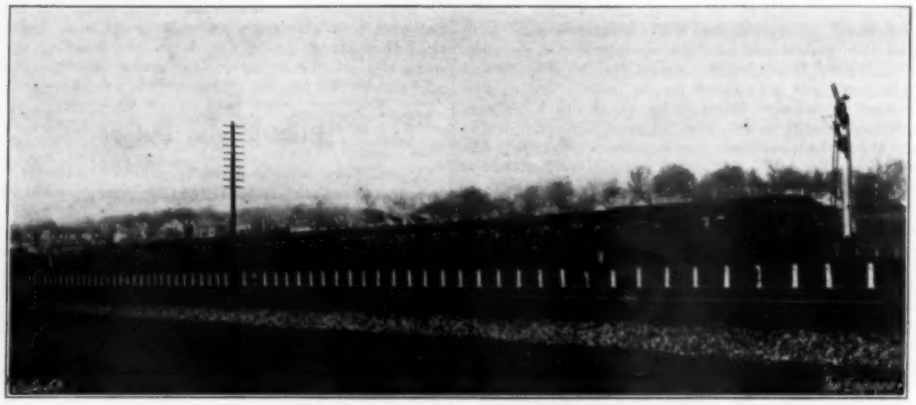


FIG. 4—METROPOLITAN ELECTRIC TRAIN ON WHICH TESTS WERE CARRIED OUT

FIG. 5—INTERIOR OF PASSENGER COACH ARRANGED FOR THE TESTS

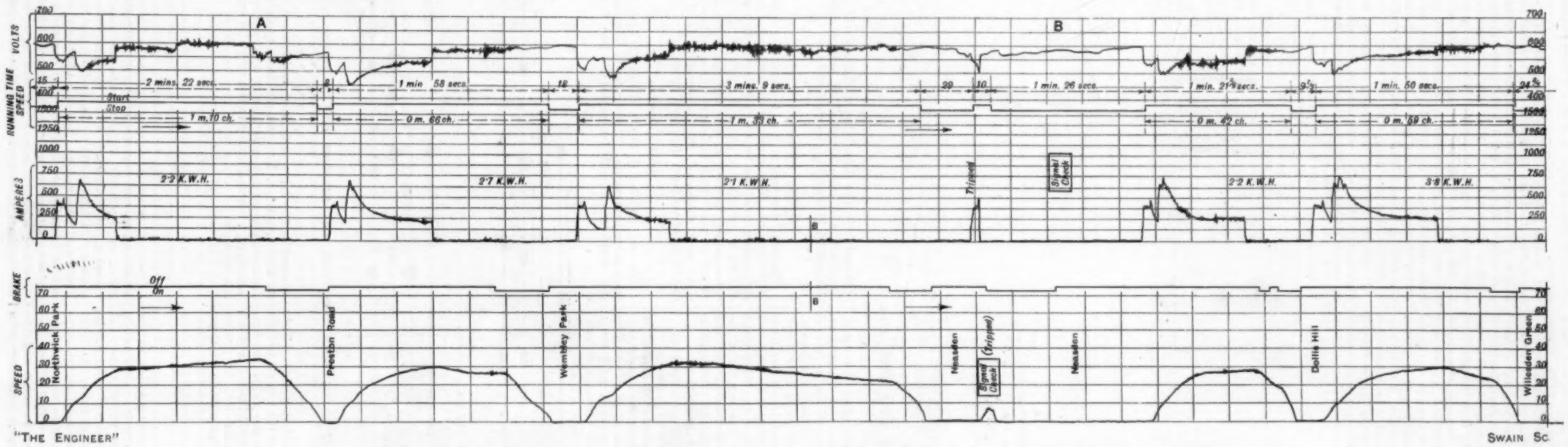


FIG. 6—REPRODUCTION OF PORTION OF CHART SHOWING RECORDS OF VOLTAGE, TIMINGS, CURRENT, BRAKE APPLICATIONS AND SPEED

engraving is sufficiently clear to note that it is set for a 36in. wheel. In the two drawers in the table are kept all necessary spares, such as pens, methylated spirit, blotting paper, fillers, charts and many other fitments which may possibly be required during the day's run.

On the right-hand side of the engraving will be seen the three watt-hour meters already described, with a table in front for the use of the observers. On the left-hand side of the picture are the direct reading instruments, one a voltmeter and the other an ammeter. The second direct reading voltmeter is placed on the table alongside the recorder. In the fore ground is placed another table, at which sit the observers responsible for the timing of the train.

The shunts for the ammeters are placed close to the equipment switchboards, the shunt leads being brought along the roof of the car to the testing compartment. One of the shunts of the watt-hour meters is also placed close to the same switchboard; another one can be noticed on the extreme right-hand side of the engraving, whilst the third one is contained in the instrument itself.

The whole of the gear inside the testing compartment can be cleared out in less than an hour. The instruments are quickly disconnected and the shunt leads pulled into the luggage compartment to be uncoupled with their shunts at a suitable opportunity. The tables are all loose and can be readily removed, whilst the partition is held in place by four moving clips. The support for the watt-hour meters drops down over the seat back. There is no necessity to make any structural alteration to the vehicle in order to install the testing equipment, and it can be placed upon any car as desired.

Test Procedure.

The operating staff numbers eleven, engaged as follows :—

1. A general supervisor.
2. An observer in charge of the recorder.
3. An observer in charge of the direct reading voltmeter.
4. An observer in charge of the direct reading ammeter.
5. An observer working the start and stop recording mechanism.
6. Two observers timing the train.

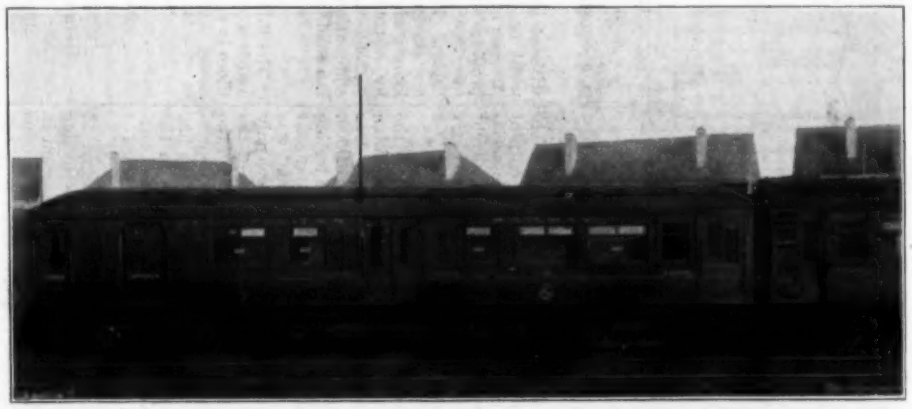


FIG. 7—EXTERIOR OF PASSENGER COACH USED FOR THE TESTS

7. One electrician in the motorman's compartment in charge of the shunts and connections.
8. One observer noting the approximate number of passengers carried.
9. One representative from the Electrical Engineering Department.
10. One representative from the Traffic Department.

In addition, extra men are carried as occasion demands in order to provide suitable relief for the observers. The work is of a particularly fatiguing nature and it is undesirable to have unduly long spells without rest.

When it is decided to carry out a test the traffic manager is requested to arrange that the train be put into a working which will enable it to visit selected parts of the line a certain number of times in the day. This ensures several trips being undertaken in the same direction and under the same conditions. Comparative results are thus obtained.

The instruments are started up when the train leaves the yard about 7.15 in the morning and are kept going until the commencement of the test at 8 a.m., so that every thing may be in proper working order. The stop watches are all carefully synchronised and checked with the standard time clock in Baker-street Station. During the progress of the test the observers in charge of the voltmeters and ammeters call out the direct readings every few minutes and thus provide a continual check on the readings shown by the recorder. On the fast runs one observer calls out the name of each station as the train passes through and an instantaneous mark is made by the stop and start recorder on the chart to indicate the exact position of the station. The instruments are kept working when the train is standing at the terminal stations, so that the charts, when pieced together, form a complete and accurate record of the whole of the running of the train for one day.

At the expiration of the day all instruments and shunts are removed by the night staff and the car is sent into traffic as usual the next morning. The charts and log books are handed over to the drawing-office and a complete set of tracings is then made of the charts showing one journey on each sheet. All the data are collated and checked and the whole of the information thus obtained is set forth on the tracings. Each drawing is thus in itself a self-contained and comprehensive record of the performance of the train which was tested on any one trip. When any question arises relating to the current consumption, station stops, speed, acceleration, braking, or other technical function of the train, the answer is given by forwarding a blue print of the appropriate chart to the department concerned. The demand for these prints from the various officials of the line has reached proportions which are almost embarrassing.

Chart Analysis.

Fig. 6 is a reproduction of a part of one of the charts

which was recently obtained during a test of the train already described when on a journey from Harrow-on-the-Hill to Baker-street and stopping at all stations, the gradient of the line upon which it travelled being shown on Fig. 8. The diagrams on the chart illustrate clearly the characteristics of a suburban train service operating on a tight schedule with a high density of traffic. In order that the maximum service may be afforded to the travelling public it is necessary that the accelerations and decelerations be as great as possible, consistent with the comfort of the passengers, that the station stops be as short in duration as circumstances will permit, and that the trains run strictly to their time-tables.

Voltage Chart.

The uppermost diagram in Fig. 6 records the track voltage. Nominally the pressure should be 600 volts, but it will be noticed that the voltage falls considerably when the motors of the train are drawing current from the conductor rails. The amount of this variation naturally depends upon the quantity of current which the train is taking, and where the ampère chart shows a maximum value the voltage chart depicts a corresponding minimum.

It is noteworthy that the average fall due to the starting up of the train was approximately 100 volts, and when leaving a station the line voltage was usually drawn down from 600 to the vicinity of 500. There was one exception, however. When the testing train was coasting down the gradient to Preston-road Station at the point marked A, when no current was passing to its motors, the voltage on the line was only 535, but by the time the train had come to rest the line voltage had increased to 570. The starting of the train consequently caused an unusually severe depression on the chart, depicting the voltage at the low level of 450. Obviously, another train was in the vicinity, and train No. 19 on the "down" road outside Harrow Station was responsible for this state of affairs.

Fig. 9 shows the disposition of the trains at 10.28 a.m., the precise moment when the testing train was at point A on the uppermost diagram in Fig. 6. It will be observed that at this time the trains were fairly well distributed over the Harrow–Baker-street section, but exactly one hour earlier they were more or less bunched up towards the Baker-street end. Consequently, the voltage curves taken at 9.38 a.m., when the testing train was between Finchley-road, Swiss Cottage and Marlborough-road, show much more serious voltage drops than are recorded in the portion of the chart reproduced.

This voltage chart presents many features of interest. It records, amongst other things, the magnitude of the current surges in the conductor rails during the accelerating periods, and from this can be deduced most valuable information for the electrical engineering department, with particular reference to the spacing of the feeders, track bonding and the necessity or otherwise of additional sub-stations or equipment.

Start and Stop Chart.

The next diagram in Fig. 6 records the time spent by the train in running and in standing at stations. As already mentioned, this part of the recorder is operated by an observer, the results being checked by the stop watches. It will be noticed that the time lost at stations varies to a considerable extent. Where there is little traffic, eight or ten seconds are sufficient to discharge and load the passengers, but for stations like Wembley Park, Neasden and Willesden Green, longer time is necessary. During the run from Harrow to Baker-street twelve stops were made, and a total time of 3 min. 39 sec. was consumed—an average of 18¼ sec. per station, which compares favourably with the general allowance of 20 sec. per station stop. The delay of 1 min. 26 sec. for a signal check in Neasden Station was due to the operation of the safety devices mentioned hereafter.

At first glance the value of this chart may not appear to be considerable, but it provides some interesting information to the traffic operating department. The chart was running at 3in. per minute, and a considerable degree of accuracy was thus obtained in depicting the time consumed by stopping at stations and at signals. With suburban traffic it is obviously of the utmost importance that lost time be cut down to a minimum, but unless a complete record of a train trip be presented to the traffic manager, it is difficult for him to realise adequately where the time has been consumed. If a systematic investigation be carried out the time occupied on a suburban run of twenty minutes may be reduced by one or even two minutes without imposing any extra strain upon the equipment or causing any inconvenience to passengers. A series of charts, such as the one now under review, provides a mass of figures of some value to the department responsible for the drawing up of new time-tables. The number of passengers travelling from any station at a given time of the day is already well known, and by providing a record of the time spent by a train in discharging and loading up these passengers, an opportunity is presented for the elimination of any excess of lost time by comparing the efficiency of one station staff with another.

Ampere Chart.

The third diagram on Fig. 7 records the current in ampères consumed by two motors, and from this there is much to learn and remark upon. It will be noted that there is a certain variation in the current fluctuations during the accelerating period. This shows that the driver did not put his control handle hard over at once, but paused on the series position. The regularity of the smaller peaks indicates that the automatic notching-up mechanism was in proper adjustment. The position and magnitude of these surges on the line as the contactors came into operation provide valuable technical information for the designing staff.

It is interesting to note the percentage of time during which the current was being applied to the motors and reference to the brake application diagram and speed diagram shows that the driver of the train was handling it in the most economical fashion. In each case the current was turned on fully, the speed of the train allowed to rise with an acceleration varying from ·75 to 1 mile per hour per second, until the maximum safe speed was reached. The current was then shut off, the train allowed to coast and the brakes applied at the latest moment consistent with the comfort of the passengers, the decelerations thus obtained varying from 1·2 to 1·6 mile per hour per second.

A bonus is given to the motormen, the amount depending upon the current which is saved over and above a predetermined allowance, and it is found that care is taken by the drivers to effect economy in current consumption. Not only is there a direct cash benefit gained by the men themselves and also by the company from the saving of electrical energy, but the maximum degree of efficiency is obtained from the electrical equipment. Further, on a suburban stopping service trains must be handled in this fashion in order to keep down the overall lengths of the journeys to a minimum.

It will be seen that between each station has been inscribed on the chart the amount of current used by two of the motors of the train. These figures were obtained from the three kilowatt-hour meters already described, and were accepted as correct after being checked by integrating the charts.

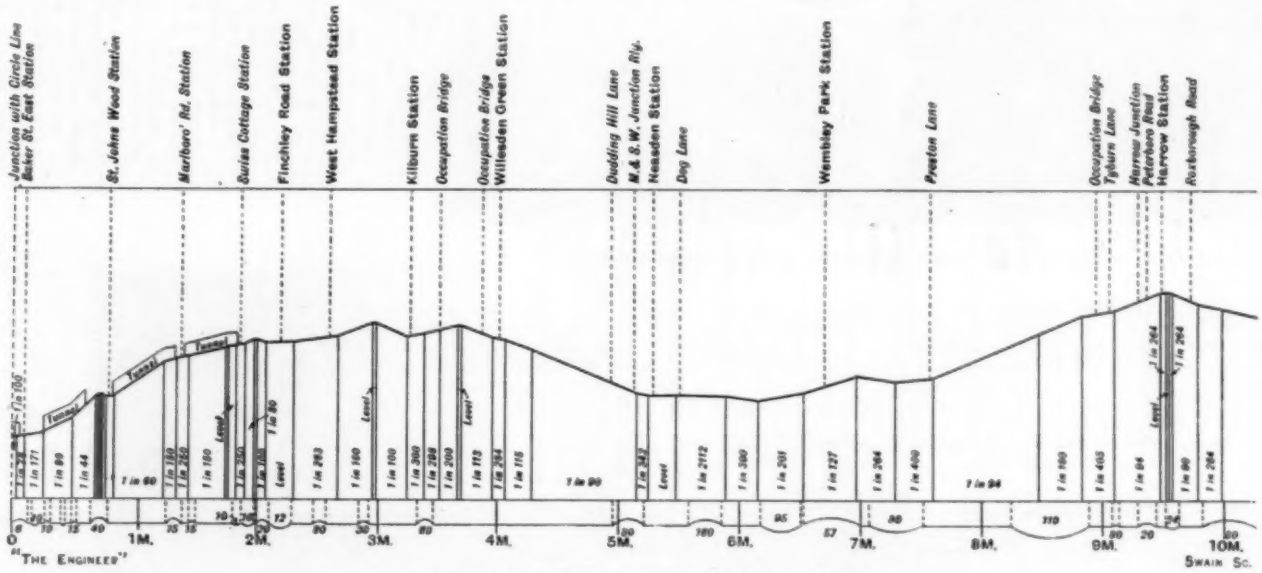


FIG. 8—PROFILE OF LINE ON WHICH TESTS WERE MADE

Brake Application Chart.

The next diagram in Fig. 6 shows the application of the brakes. This mechanism is operated from the air passing into the brake cylinders and a pressure of 5 lb. is sufficient to cause the pen to move. It is not necessary to show on the chart the degree of application, as that would introduce undesirable complications, and, moreover, the deceleration of the train can be observed from the speed curve.

Speed Curves.

The last diagram in Fig. 6 shows the speed of the train at various points. The regularity of acceleration and deceleration will be noticed. The former is effected by the driver only in changing from series to parallel operation, but the deceleration is entirely dependent upon his skill in the application of the brakes, and the uniformity in the rate of deceleration is noticeable.

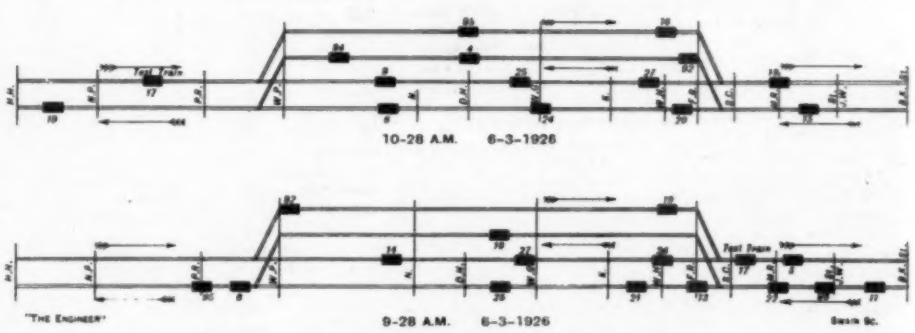


FIG. 9—DISTRIBUTION OF TRAINS WHEN TEST TRAIN WAS AT POINT "A" IN FIG. 6

Chart Oscillation.

The vertical vibrations on all chart lines will be commented upon. They are caused by the oscillation of the car, and when it is found on different charts to occur at the same position it points to the necessity of the permanent way receiving some attention. As stated earlier in the article, if the instrument were placed in the direction in which the train is travelling these oscillations would be damped out and a steadier line would be obtained; but this additional record is one of considerable interest when questions of permanent way maintenance or the design of new rolling stock are being considered. It will be noticed that on the chart are placed all the data referring to the

tests, so that it is self-contained and forms a complete history of the test.

SAFETY DEVICES.

On referring to the ampère chart it will be remarked that when leaving Neasden the current was turned on for some seven seconds and then abruptly cut off. As already mentioned, the signalling on the electrified portions of the Metropolitan Railway is automatic, and in order to prevent the trains passing signals at danger an elaborate system of safety devices is fitted to the signals and motor cars. When a signal is "on," a T-headed arm situated close to the running rail rises to the vertical position and should a train pass this signal the arm will engage on the handle of a trip cock placed in the brake train pipe of the motor car. An emergency application of brakes will be made and the train quickly brought to a standstill.

It must not be assumed, however, that trains are tripped solely on account of the motormen passing a signal at danger. The signalling gear is designed so that if it fails in any way whatsoever the semaphores will always return to the safe position. Tests of the safety devices are carried out at regular intervals—every time a train passes through St. John's Wood-road or Euston-square its trip cocks are automatically gauged—and advantage was taken on this occasion to test out all the gear. The trip arm was disconnected from the signal, fixed in a vertical or "danger" position, and as the train passed over the brakes were applied. The history of the incident is fully recorded on the chart. The train had been travelling for about seven seconds when the brakes went on, the speed attained being about 6 miles per hour. The current was shut off instantly by the motorman, and it is interesting to note how close together are the movements of the pens showing the rupturing of current, the operation of the brakes and the slowing down of the train.

The information to be gained from this incident is of value. The rapid deceleration shown on the speed curve indicates that the brake gear was in good working order. The speed of the chart being known, the distance the train travelled before it finally came to rest can be ascertained, and from this the Signal Superintendent can calculate whether the overlaps are sufficient to prevent the train running into danger after it has been tripped. The vigilance and resourcefulness of the driver are evident in the promptitude with which the current was cut off, thereby saving any danger of straining the equipment through having current and brakes on at the same time. In more modern rolling stock an application of the brakes through the action of the trip cock automatically cuts off the current.

Table of Watt-Hour Readings.

Stations.	Kilowatt-hour readings.	Total for train.
Harrow to Northwick Park	2·0	8·0
Northwick Park to Preston-road	2·2	8·8
Preston-road to Wembley Park	2·7	10·8
Wembley Park to Neasden	2·1	8·4
Neasden to Dollis Hill	2·2	8·8
Dollis Hill to Willesden Green	3·8	15·2
Willesden Green to Kilburn	4·0	16·0
Kilburn to West Hampstead	4·0	16·0
West Hampstead to Finchley-road	3·8	15·2
Finchley-road to Swiss Cottage	2·2	8·8
Swiss Cottage to Marlborough-road	3·0	12·0
Marlborough-road to St. John's Wood-road	2·0	8·0
St. John's Wood-road to Baker-street	1·8	7·2
Total	35·8	143·2

WATT HOURS.

The Table shows the results obtained from the watt-hour meters during this run. The weight of the train being known, in conjunction with the observed number of passengers, the actual consumption in watt hours per ton-mile can be readily calculated. This figure is used as a basis for determining the relative efficiency of different types of stock and for many other technical and accounting purposes.

LOCOMOTIVE TESTING.

The tests of electric locomotives are carried out in much the same way as are those on motor cars, but as there is no space in which to install the instruments on the locomotives it is necessary to attach a special testing coach. A third-class brake coach is used for the purpose, the instruments being fitted up in the luggage compartment and the observers travelling in one of the compartments. The arrangements for timing and checking are precisely the same as obtain on other tests. The shunts are placed inside the locomotive and the leads are carried along the roof and down to the various instruments. The special truck upon which is mounted the driving gear for the speed transmitters is placed below the brake coach before it leaves the shops.

The traction recorder is also used for taking records of the voltage on the track when a series of controller failures points to the probability of specially low voltage in some section of the line. It is occasionally necessary to determine the speed of the trains at different points of the line, and for that purpose the speed recording mechanism is called into use.

CONCLUSION.

With the severe competition which prevails in the London transport area at the present time it is necessary that every economy be effected, and it is only by tackling all the problems of expense and maintenance in a scientific fashion that accurate data can be obtained. It has therefore been considered by the Metropolitan Railway that no effort should be spared to make the train testing apparatus as accurate as possible in order that the results might be reliable and complete, for upon them the operation of existing rolling stock and the design of new vehicles must depend to a considerable degree.

The Battle of Jutland: A Retrospect.

NEXT Monday, May 31st, will be the tenth anniversary of the Battle of Jutland, the greatest naval action of modern times, when the two most powerful and most efficient fleets of their day measured their strength one against the other. Jutland will, we are convinced, be recorded in history as one of the decisive battles of the world. It is true that the losses in men and ships were not particularly severe, having regard to the magnitude of the forces engaged. It is true, also, that each of the contending fleets emerged from the conflict with its material fighting strength not permanently impaired. But, judged by its after-effects, the battle was unquestionably decisive. Although the war continued for a further thirty months, the German High Sea Fleet never again accepted battle. After Jutland it became to all intents a passive factor, a mere "fleet in being," though without exerting on the strategic situation in general that weighty influence which the phrase was originally held to imply. The subsequent development of submarine warfare on commerce was in itself a plain admission that the German battle-fleet no longer felt competent to challenge Britain's command of the sea, and was therefore unequal to the task for which it had been created. The events of May 31st–June 1st, 1916, by establishing our naval supremacy on an impregnable foundation, contributed in the most decisive manner to the ultimate defeat of the Central Powers. In this verdict all parties will, we think, concur. The only grounds for controversy are those relating to the strategic movements before the battle, the actual tactics employed, and the quality of the opposing weapons. On each and all of these questions a marked divergence of opinion exists, not only as between British and German critics, but among British naval officers themselves, to say nothing of non-professional students and neutral observers.

While we do not propose to join in the controversy on the strategy and leadership of the Grand Fleet, we cannot refrain from pointing out that a great deal of argument might have been spared had the protagonists spent more time in studying the official despatches and the other authoritative data on Jutland which have been accessible for some years past. It is perfectly clear that, on the British side at all events, the battle was fought according to plan. As early as October 30th, 1914, Admiral Jellicoe had explained in a memorandum to the Admiralty the course he proposed to follow in certain contingencies. Dealing, for example, with the possibility that the Germans might use their submarines in conjunction with the battle fleet, he wrote :—

"The move can be countered by judicious handling of our battle fleet, but may, and probably will, involve a refusal to comply with the enemy's tactics by moving in the invited direction. If, for instance, the enemy battle-fleet were to turn away from an advancing fleet, I should assume that the intention was to lead us over mines and submarines, *and should decline to be so drawn*. I desire particularly to draw the attention of their Lordships to this point, since it may be deemed a refusal of battle, and, indeed, might possibly result in failure to bring the enemy to action as soon as is expected and hoped. . . . I feel that such tactics, if not understood, may bring odium upon me, but so long as I have the confidence of their Lordships, I intend to pursue what is, in my considered opinion, the proper course to defeat and annihilate the enemy's battle-fleet, without regard to uninstructed opinion or criticism."

The tactics thus foreshadowed, and unreservedly approved by the Admiralty in its reply of November 7th, 1914, were adhered to substantially when the day of battle came. Admiral Jellicoe met the threat of torpedo attack by turning away the Fleet a few points. This movement necessarily opened the range, but, as is clearly shown in the charts of the action, not to such a degree as would have prevented accurate fire had the visibility remained fairly good. As it happened, however, the main Fleet did not make contact with the enemy until 6 p.m., by which time a haze had spread over the battle zone, and vision was further obscured by the funnel and gun smoke of scores of ships, all steaming at full power and many firing incessantly. Under such conditions, "decisive range" became of necessity a very elastic term. At more than one period hostile ships at a distance of only a few thousand yards were practically invisible. The gunnery records of our ships show that no opportunity was missed of delivering the heaviest possible fire against such targets as could be made out, and that this fire was effective is proved by the damage sustained by many of the German battleships, which on their part failed to score a single direct hit on our battle fleet. The point we wish to emphasise is that low visibility, and not the turn-away movements of the Grand Fleet, was the main factor in facilitating the escape of the German forces. However closely Admiral Jellicoe might have approached, it is exceedingly doubtful whether the Fleet as a whole could have developed that full and continuous broadside fire which might have annihilated the enemy. At no time from 6 p.m. onward were more than isolated detachments of the High Sea Fleet within view of all our ships. Nor should it be forgotten that the partial fog in which the battle area was shrouded would have been all in favour of the German torpedo craft had our battleships attempted to close. Critical accounts of the Jutland action which ignore this essential element of visibility are valueless, and may therefore be discounted.

In spite of strong evidence to the contrary, the Battle of Jutland is often referred to as having been an unpremeditated and fortuitous encounter. So far as the Germans were concerned, it is true that they were taken by surprise. For some days beforehand, however, the unusual wireless activity along the east coast of the North Sea had apprised our authorities of an impending move by the German naval forces. A note prefacing the record of signals in the "Jutland Papers" states that "on May 30th, 1916, the Admiralty received news which pointed to early activity on the part of the German Fleet," and was, of course, instantly communicated to Admiral Jellicoe. In consequence of this intelligence, the Grand Fleet left Scapa at 9.30 p.m. the same day, to concentrate on its usual "beat" eastward of the "Long Forties," which extended some hundred miles east of the Aberdeen coast, with a reasonable expectation of sighting at least a portion of the German Fleet, such as the battle-cruiser squadron and attendant light forces. The High Sea Fleet, which did not sail from the Jade till 2–2.30 a.m. on the 31st, was apparently unaware that its wireless messages betraying the impending sortie had been intercepted, since all German accounts agree that the subsequent meeting with the Grand Fleet came as a complete surprise. Admiral Scheer had originally meant to cross the North Sea and bombard Sunderland, the object being, in his own words, "to compel the enemy to put to sea, by making an advance with our fleet, and to give battle under conditions favourable to us." But his plan entailed reconnaissance by airships, and when day after day the weather conditions rendered this impossible, the Sunderland raid was given up and a less ambitious operation substituted for it. This was to make an advance towards the Skagerrak and attack such merchant traffic as might be found in those waters, with the ulterior motive of enticing out one or more squadrons of the British Fleet and falling upon them in overwhelming force. German battle-cruisers were to furnish the bait, while three battleship squadrons followed at a discreet distance, ready to pounce when the prey had been lured into the requisite position.

As it chanced, the date selected by Germany for her supreme naval demonstration was a fortunate one for us, since it found the Grand Fleet with all but four of its major ships ready for immediate action, the only absentees in dockyard being the battleships Queen Elizabeth, Emperor of India, and Dreadnought, and the battle-cruiser Australia. The rival fleets were composed as follows :—

British Grand Fleet :—28 Dreadnoughts, 9 battle-cruisers, 8 armoured cruisers, 25 light cruisers, 80 destroyers.

German High Sea Fleet :—16 Dreadnoughts, 5 battle-cruisers, 6 pre-Dreadnought battleships, 11 light cruisers, 77 destroyers. (Attached to, but not actually present with the German Fleet, were 16 submarines and 10 Zeppelins).

The Grand Fleet's superiority in every type of ship save destroyers was very marked, and might even have been termed overwhelming. In weight of broadside its advantage was more pronounced than the respective ship totals indicate, because of the heavier metal carried by our capital units. These mounted between them 344 big guns, of which 48 were of 15in., 152 of 13·5in., and 144 of 12in. calibre. The German heavy artillery comprised 244 pieces, of which 144 were of 12in. and 100 of 11in. calibre, 24 of the latter being of an old mark. Of medium calibre guns the Grand Fleet had 36 9·2in. pieces, and the German fleet none. The collective speed of the Grand Fleet was higher by at least 2 knots than that of its adversary. In one respect only did the Germans possess an advantage, though it was destined to be of incalculable benefit to them. Their ships were admirably protected, both as to armour and subdivision, and proved able to endure very severe punishment without being sunk or even disabled.

It is not necessary to recount the details of the battle itself, and we shall only sketch the chief phases in broad outline. At or about 3.45 p.m. on May 31st our Battle Cruiser Fleet came within range of the German First Scouting Group, comprising five battle-cruisers, both sides opening fire simultaneously. The initial salvoes were discharged at a distance of 16,500 yards, but as the two lines were converging at high speed the range closed rapidly, and a few minutes later it was down to 13,000 yards. Hitting began almost at once. The Germans having the best of visibility—our ships being clearly silhouetted against the bright Western sky—inflicted more punishment than they received. Of this phase Lord Jellicoe wrote

in his dispatch :—"It is undoubted that the gunnery of the German battle-cruisers in the early stages was of a very high standard. They appeared to get on to their target and establish hitting within two or three minutes of opening fire in almost every case, and this at very long ranges of 18,000 yards. . . The 'spread' for both direction and elevation is very small, and the rapidity of fire very great." The first dangerous hit recorded was on the Lion, a few minutes after 4 p.m., a shell piercing Q-turret and killing nearly all the occupants. But for the heroism of the turret officer, Major F. J. W. Harvey, R.M.L.I., who, although mortally wounded, passed the word down to close the magazine doors and flood the magazines, the ship would probably have been destroyed. Almost at the same moment the Indefatigable, which, as rear ship of the line, had been engaging her opposite number the Von der Tann, was hit by two salvoes in succession. Her magazines exploded, and she sank with practically all hands. At 4.10 the Fifth Battle Squadron—four "Queen Elizabeths"—under Admiral Evan Thomas, came into action with its 15in. guns at 19,000 yards, delivering a most accurate fire, which forced the German ships to alter course repeatedly. At 4.20 the Queen Mary, engaged with the Derfflinger and Seydlitz, blew up in one tremendous eruption, nothing remaining of her but "a dark pillar of smoke rising stemlike till it spread hundreds of feet high in the likeness of a vast palm tree." At this juncture reciprocal destroyer attacks were delivered, as a result of which the Seydlitz was torpedoed near the bows, but was able to keep station in the line. All the German torpedoes ran wide. Meanwhile the German battle fleet had been sighted, whereupon Admiral Beatty led his depleted force northward to make contact with the main body and to draw the enemy after him into the jaws of the Grand Fleet.

It was now that the Fifth Battle Squadron, three miles astern of the battle-cruisers, came under fire of a whole squadron of German battleships. The Barham and Malaya suffered severely and had many casualties; but gradually the range opened, and the advantage in length of reach which our heavy guns had was turned to good use, many hits being scored on the German ships, whose return fire became ineffective. There now ensued a brief pause in the main action, for the two fleets were momentarily out of touch; but Admiral Hood, with the Third Battle Cruiser Squadron—three "Invincibles"—attached to the Grand Fleet, was near at hand, and one of his light cruisers, the Chester, while reconnoitring ahead, ran into a German cruiser division and was roughly handled. But her persecutors paid the penalty when the Invincible suddenly emerged from the mist and opened on them with 12in. salvoes, which instantly disabled the Wiesbaden and all but wrecked the Pillau and Frankfurt. Following the "Invincibles" came Admiral Arbuthnot's First Cruiser Squadron of old armoured cruisers, which fired heavily into the doomed Wiesbaden until they in turn came under a hurricane of fire from the German battle-cruisers. The flagship Defence, hit by two full salvoes, "disappeared in a roar of flame," at 6.20, and the Warrior, with riddled hull and damaged engines, limped away from the scene, only to founder on the following day. Yet another catastrophe was soon to overtake the Grand Fleet. Admiral Hood had swung his three ships into line ahead of Beatty's devoted squadron, and was now hammering the German van at a range of only 9000 yards. Every shot was telling, but the enemy, seeing the Invincible defined against a patch of evening sky, replied with rapid salvoes, and it was not long ere the archetype of all battle-cruisers, riven by tremendous explosions, broke in two and went down. Four ships had thus met their fate in almost identical circumstances. In each case shells had penetrated, either directly or indirectly, to a magazine, the detonation of which had touched off other magazines and so brought about the total destruction of the ship. The fact that the cruiser Defence went the way of her battle-cruiser consorts is clear evidence that the vulnerable point, whatever it might be, was not peculiar to ships of the all-big-gun type.

The Grand Fleet, having completed its deployment, came into action at 6.30. Fire was now beating upon the head of the German line from eight points of the compass, and whether it was due to bad visibility or to the demoralisation which may have set in when the German crews realised the appalling danger of their position, the fact remains that their return fire was wild and utterly ineffective. Admiral Scheer rescued his fleet from what seemed to be certain destruction by executing a turn-away together (*Gefechtskehrtwendung*), a complicated manœuvre which had been constantly practised in peace. It was performed successfully under cover of a smoke screen, and the hard-pressed German Fleet gained a brief respite. An attack delivered by their destroyers proved but a blow in the air, for it has been established that the torpedo which hit the Marlborough at 6.54 came from the disabled cruiser Wiesbaden. At 7.10 the Grand Fleet, thanks to skilful manœuvring, was again in contact with the enemy's main body, and during the next fifteen minutes the cannonade rose to a crescendo of fury. This was the stage at which the Germans suffered their heaviest casualties. Shells hacked through their stoutest armour, cascades of water poured through the gaping rents in their hulls, several ships had one or more turrets blown up, and the decks were littered with dead. That the majority of the German ships should have survived this fiery ordeal is certainly a fine testimonial to the staunchness of their construction. Once more, however, Admiral Scheer extricated his fleet by turning it away together. But Beatty was hard on his heels, and at 8.20 he again poured in a devastating fire, which was kept up until the intervention of the German Second Battle Squadron—consisting of pre-Dreadnoughts, but apparently mistaken for heavier ships—compelled our battle-cruisers to open the range. This was to be the final clash between the main fleets. Under cover of darkness, Scheer contrived to lead his sorely battered force homeward, passing astern of our line without definite news of his position reaching Admiral Jellicoe until too late. There was a number of sharp cruiser and destroyer actions during the night, and a grim tragedy occured in the small hours of June 1st, when the cruiser Black Prince, which had completely lost touch with the Fleet, suddenly found herself within point-blank range of the German battleships. Caught in the glare of searchlights, she was reduced in the space of two minutes to a mass of flames, and blew up with all on board. Against this loss we could set the destruction of the German battleship Pommern, the magazines of which were detonated by a torpedo from one of our destroyers, and the light cruisers Rostock and Frauenlob, also torpedoed during the night. Another cruiser, the Elbing, was so severely injured in collision that she had to be scuttled. Most grievous of all to the Germans was the loss of their finest battle-cruiser, the Lützow, which had been so knocked about by our guns that she became waterlogged and had to be sunk by a torpedo.

Only the proximity of their bases saved several other German ships from foundering. The battle-cruiser Seydlitz was towed into Wilhelmshaven stern foremost, with her lofty forecastle under water; the Derfflinger was scarcely more seaworthy, and both the Moltke and Von der Tann were riddled with shell. The battleship Ostfriesland struck a mine during the retreat, but managed to get in under her own steam. Four other great ships sustained extensive material damage, and heavy casualties to *personnel*. On the German side there was never any serious question of renewing the battle. Admiral Scheer himself makes this clear. In his despatch to the Kaiser he wrote: "Reports from the armoured cruisers showed that the 1st Scouting Group—*i.e.*, his battle-cruisers—could no longer fight a serious action. The ships in the van of the 3rd Squadron—*i.e.*, his most powerful Dreadnoughts—must also have lost in fighting value. Of fast light cruisers, only the Frankfurt, Pillau, and Regensburg were at my disposal." He added that the consequences of a fresh encounter would have been "a matter of chance." At that time, of course, he did not know precisely the condition in which the Grand Fleet remained. Had he possessed such knowledge he would doubtless have owned that a renewal of the battle must, in all human probability, have ended in the total destruction of his fleet. For the Grand Fleet, notwithstanding its painful losses, was able on the morning of June 1st to muster an overwhelming force. Apart from the Lion, all our surviving battle-cruisers, five in number, were in a condition to fight, three of them not having been touched. The only battleships of which the fighting power had been at all impaired were the Barham, Malaya, Warspite and Marlborough. Twenty-four other battleships remained in perfect condition for action. Five light cruisers were temporarily disabled, leaving twenty others fully available for any service. And four-fifths of the destroyers could have gone into action again had a reserve of torpedoes been at hand. Clearly, therefore, the Germans had ample cause to congratulate themselves that the battle did not break out afresh on June 1st.

Their claim to have achieved a victory at Jutland is based solely on a comparison of losses. They had sunk three of our battle-cruisers, three armoured cruisers and eight destroyers, while we had destroyed one German battle-cruiser, one old battleship, four light cruisers, and five destroyers. The casualties among *personnel* were 6784 in the British and 3039 in the German Fleet. Our heavy losses in officers and men were due in the main to the blowing up of five great ships, virtually with all hands. The German vessels, on the other hand, though they received in the aggregate a larger number of hits, did not explode—the Pommern being the only exception—and even when reduced to sinking condition generally kept afloat long enough for their crews to be taken off. Nevertheless, in its broad results the battle was, as we have contended, a decisive victory for British sea power. If the Grand Fleet failed to destroy the enemy, at least it gave such a demonstration of its tremendous power as to convince the Germans of the futility of risking a second encounter with it. As a leading German naval critic has since confessed: "The losses sustained by our High Sea Fleet were enormous, in spite of the fact that luck was on our side; and on June 1st, 1916, it was clear to all intelligence that this fight would and must be the only one to take place. Those in authority have often openly admitted this." That admission disposes of the German claim to have won the Battle of Jutland. Technical and other lessons of the battle are considered elsewhere in this issue. Here it need only be said that while certain shortcomings in the design and equipment of our ships were revealed, the naval organisation as a whole, both as to *personnel* and material, came through the supreme test magnificently. In those crowded hours of daylight and darkness, the British people reaped the reward of many years of effort and sacrifice on behalf of their incomparable Navy. More than once in the pre-war era were the strength and efficiency of the naval arm menaced by ill-judged measures of economy, and only the resolute determination of the people as a whole saved the Fleet from reductions which might have proved fatal. We can but hope that the British public will not allow itself to be misled by doctrinaires into renouncing its traditional faith in the Navy as our principal shield against foreign aggression. We agree that an adequate system of air defence is essential to our future security, but we dissent most emphatically from the view that naval power has ceased to be vital and may with impunity be neglected in the years to come.

Freight Rates in Belgium.

(*By Our Special Representative on the Continent.*)

THE very low freight rates prevailing on the Belgian State Railways have always been a cause of envy on the part of British manufacturers and exporters, and attention has again been directed to them by the announcement that certain increases are to come into force on June 1st. That increases are long overdue, in the interests of the Belgian people themselves, is generally admitted. Action, however, has been delayed to the last moment owing to the conflict of opinion with regard to policy. One school of thought, with an eye on the serious financial situation of the country, wished to see the railways in a position to earn revenue for the State, and considered that an average increase of 25 per cent. in rates ought to be made. On the other hand, there was a strong party supporting the traditional policy that the railways should not consider profits at all, but should be regarded primarily as an essential service to the community. This party, which naturally included the Government officials responsible for the administration of the railways, maintained that a 10 per cent. increase would be ample and would leave a substantial margin for contingencies. The decision finally arrived at is no simple all-round percentage increase. Some tariffs are unchanged and others are increased by 5, 10, and 15 per cent. respectively. In order to give a general idea as to the situation a little preliminary explanation of the Belgian system is necessary.

There are in Belgium six goods tariffs, exclusive of special tariffs. Tariffs No. 1 and 2 refer to small consignments sent by fast trains. Tariff 3 applies to ordinary merchandise of all kinds, which is divided into six classes. Tariff 4 applies to works of art and valuable objects. Tariff 5 to carriages and automobiles, and Tariff 6 to horses, cattle, &c. By the new order, Tariffs 1, 2, 4, 5, 6 and all special tariffs remain unchanged. It is therefore Tariff 3 which demands particular attention, not only because the rates are increased, but because apart from special tariffs, this is the one of greatest interest to engineers. Some of the most important special tariffs will be referred to later.

Tariff No. 3 is, as has been mentioned, divided into six classes, with different rates for the kind of merchandise belonging to each class. In general the classification is in accordance with the roughness and robustness of the goods. Class 1 contains delicate and damagable articles, such as chemicals, medicines, wires, electric cables, cotton and woollen goods and furniture; Class 2 includes general machinery and engines, raw cotton, hides, &c.; Class 3 includes general steel and ironware, polished or sculptured stone, &c.; Class 4 comprises grindstones, tiles, flour, cement, hay, &c.; Class 5 includes coke, rough castings, drainage tiles, old iron, old timber, domestic coal, &c.; while the roughest goods, such as ashes, chalk, clinkers, brickbats, industrial coal, artificial paving stones, and general trade refuse come under Class 6. The underlying idea of the classification is fairly clear. We have, for example, raw jute coming under Class 3, combed or carded jute under Class 2, while when the same material is spun it is elevated into Class 1. Plain bedsteads come under Class 3, but when decorated they presumably need more care in handling and so are listed as Class 1 goods. Empty bags, used, are in Class 3, whereas when new they are in Class 2, and so on. For every one of these six classes of goods there are three rates, A, B, and C, depending on the weight of the consignment. For the first four classes rates A apply to consignments up to 5 tons, rates B to consignments up to 10 tons, and rates C up to 15 tons. For Classes 5 and 6 rates A apply to consignments up to 10 tons, rates B to 15 tons, and rates C to 20 tons. Consignments of less than these minimum weights are charged at the weights respectively, unless the "*Tarif des charges incomplètes*" is more favourable to the consignor, and for weights in excess of these minima the rates are calculated in units of 2 cwt.

The rates under Tariff 3 are to be altered in accordance with the following scheme:—For the classes of goods Nos. 1, 2, 3, 4, and 6 the A rates will be increased by 15 per cent., the B rates by 10 per cent., and the

C rates by 5 per cent. For Class 5 the A rates will be increased by 10 per cent., the B rates by 5 per cent., while the C rates will be unaltered. The general effect, therefore, of the decision of the Minister of Railways will be to increase the cost of sending general merchandise by goods train by a maximum of 15 per cent. The small shipper is hit harder than the man who can send two or three times as much at a consignment. Express traffic and the traffic in cattle, motor cars, and works of art are not to be increased in cost. What effect the alterations in rates will have on trade it is not easy to say, but one can be fairly sure that it will be very slight. The rates now are so very low that even the maximum increase of 15 per cent. should give no real grounds for complaint. Moreover, the numerous special tariffs designed to assist the export industries of the country are unaltered, so that a very large amount of traffic will suffer no increase in rates at all. What really remains to be seen is whether the increases in the cost of transport of goods coming under Tariff 3 will be adequate or anything like adequate to meet the revenue needs of the railways, even with the assistance of the general 6 per cent. rise in passenger fares which is also to come into force.

To give an example of the rates now existing we will take the case of rough castings. These are included under Class 5 of Tariff 3, and special Tariffs 12 and 13 also apply in certain instances. The following table is translated from the "Recueil Officiel des Tarifs" of the Belgian State Railways, published January 1st, 1926, and applies to Tariff 5, Class 3, goods, which include not only iron castings, but domestic coal and rough merchandise generally. For the purpose of translation the metric ton of 2204 lb. has been taken as equal to the English long ton of 2240 lb., the distances in miles are fractionally less than the actual distances in kilometres, and the franc has been taken at the exchange rate of 160 to the pound sterling. The franc is actually cheaper than this at the time of writing.

TABLE I.—*Freight of Iron Castings in Pence per Ton.*

Distance in miles.	5-ton lots.	10-ton lots.	15-ton lots.
1	4·20	4·05	3·90
20	15·60	14·85	14·40
50	27·90	26·55	25·65
100	34·65	33·15	31·80
200	45·75	43·80	42·00

It will thus be seen that in Belgium one can send a 15-ton load of castings 200 miles for 3s. 6d. per ton. Under the new tariff the cost will not be increased, although for a 5-ton load sent the same distance the cost will be increased from 3s. 9·75d. to 4s. 2·33d. There are, of course, supplementary charges, but they are very trifling. Loading and unloading are performed at the rate of 0·75d. per cwt., or if the loading is done by the sender it will be supervised for 3·15d. per ton. If a crane is needed, its services will be charged at the rate of 0·30d. per cwt.

If our hypothetical sender of iron castings is consigning them for export and is sending, or is willing to pay for, a minimum load of 20 tons, he may take advantage of the special tariffs already referred to. Both the Tariffs 12 and 13 apply to goods sent to Brussels, Antwerp, Louvain, Termonde, Ghent, Bruges, Ostend, Nieuport, and Zeebrugge, and destined for export by sea-going ships. The difference between the two tariffs depends on whether or not the goods are dispatched from one of a specified list of stations which serve the metallurgical industries of Belgium. There are about 180 such stations listed, so that the restriction imposed by this condition is not unduly severe. Under Tariff 12 the castings may be sent from any station in Belgium, whereas Tariff 13 applies to dispatch from some one or other of the stations listed. The following table gives the rates at present in force under the respective conditions, and, as has been mentioned, there is no present intention of altering these rates :—

TABLE II.—*Freight of Iron Castings for Export in Pence per Ton (Minimum Shipment 20 Tons).*

Distance in miles.	Tariff 12.	Tariff 13.
1	3·00	7·35
20	11·10	7·35
50	19·65	13·95
100	22·20	18·15
200	28·28	24·90

To be able to send 20 tons of castings a distance of 200 miles for £2 1s. 6d. is obviously a considerable encouragement to export trade, and no doubt has its effect is assisting Belgian competition with British industry. Among other articles of engineering interest which are given the advantage of the tariff rates indicated in Table II. above, are railway tires, axles, brake shoes, spikes and rails ; steel plates, joists and sections ; cast iron pipes, fuel economisers, &c.

A MESSAGE from Beyrouth says that in accordance with a decree of the Governor of Great Lebanon, the Société des Forces de la Khadiehach has begun the construction of a hydro-electric power station, with an initial capacity of 1500 horse-power, which can be brought up to 3000 horse-power by using another waterfall. The new station is to supply light to Tripoli, Charré, Masroum, and Edho. The company, which is composed exclusively of local interests, intends shortly to build a similar station for the town of Zahlé.

Books of Reference.

"THE Empire Municipal Directory and Year Book, 1926–1927," published by *Municipal Engineering and the Sanitary Record* (the Sanitary Publishing Company, Ltd.), 8, Breams-buildings, London, E.C. 4, price 10s. 6d. net. This is the forty-fourth annual issue of this extremely useful book of reference, and it is indistinguishable in outward appearance from those which have preceded it. Within its covers, however, we notice a number of changes, though Section I., which, as usual, embodies the invaluable directory of Local Authorities throughout the Empire and their officials, remains unaltered, saving that it has been brought thoroughly up to date, the lists in large majority of cases having been corrected by the Authorities themselves. For the remainder of the volume, the same arrangement has been adopted as in former issues, saving that what was Section VIII., "Health Officials and Sanitation," in the 1925–26 issue, has been omitted. But though the rest of the Sections are retained and are arranged in the same sequence, we notice that in nearly every case the text has been extensively rewritten, the new matter dealing with questions of topical interest or relating to progress made during the year. Naturally, the utility and interest of the volume has been considerably increased in consequence. The Buyers' Guide, the lists of books likely to be useful to the engineer, the sanitarian, fire brigade officers, builders, architects, health officers, food inspectors, &c., and the week-to-a-page diary at the end go to make complete a really valuable addition to the municipal engineer's library.

"THE Railway Year Book, 1926," is issued by the Railway Publishing Company, Ltd., Tothill-street, Westminster, London, S.W. 1, price 5s. net. The present edition forms the twenty-ninth annual issue. The publishers point out that although there have not been so many changes in the last two or three editions of this book of reference as there were in those of the preceding years — since the reorganisation and other inevitable changes incidental to the grouping of the British railways have now, to all intents and purposes, been effected, while amalgamative procedure in the Irish Free State is now virtually finished—the present volume may be regarded as the first in which offical, statistical and historical information concerning all the railways is set forth on a substantially permanent ba is. The most essential change is that the section devoted to the Great Southern Railways (Ireland) is now presented in a form which will, presumably, cover the situation for some years ahead, except for the usual annual revision. Of the eleven large folded and eleven smaller maps, those for the Southern London "Underground," Australian and Canadian railways are new, while several others have been corrected to bring them up to date. The "Who's Who" section also includes a large number of additional biographies, and the whole book has been carefully revised so as to bring it, as nearly as possible, up to date.

"THE Port of Hull Annual" is issued at the office of the *Port of Hull Monthly Journal*, Bishop-lane, Hull, price 3s. 6d. The 1926 edition in no way falls behind those which have preceded it, and it is brimful of information concerning the various Humber ports. There is first of all a section dealing generally with the facilities for trade offered by the Humber at the present time. Then there is an account of a visit paid to Hull by representatives of the British Empire in 1925, which is followed by sections devoted to the Yorkshire and Midland coalfields ; Humber Trade in 1925 ; Coal Supplies and Shipments in 1925 ; Inland Water Transport ; a list of Hull-owned Steamships ; Hull Shipping in 1925 ; Shipbuilding on the Humber in 1925 ; Bulk Oil-handling at Hull ; the Grain Trade ; the Timber Trade ; the Port Agency ; the Vegetable Oil Industry ; the Fruit Trade ; the Humber Fisheries, and a classified list of goods imported into Hull. Then there is a section dealing with Grimsby and Immingham, and another containing a classified list of goods imported at those ports. The two final sections are concerned with the Port of Goole, and a review of the Hull markets in 1925 and prices current. In fact, the annual is an extremely useful book of reference regarding all the Humber ports.

"THE *Electrician* Annual Tables of Electricity Undertakings," which is published by Benn Brothers, Ltd., 8, Bouverie-street, London, E.C. 4, at 10s. net, has just appeared in the 1926 issue in its thirty-ninth edition. There is no need for us to describe the contents of these periodically published tables ; they are too well known by now. We may say, however, that several stations having made use of oil fuel, the opportunity has been taken to include some particulars of the oil-burning apparatus employed by a number of undertakings. Additional information regarding the mains and distributors, converting plant, output for the year, show-rooms, &c., have been inserted in the present edition. All the British, and as many of the colonial and foreign sections of the tables as possible, have been brought up to date, the necessary information having been obtained from the engineers and managers of the various undertakings.

"THE Directory and Guide to the Manchester Royal Exchange, Ltd., for 1926," is obtainable from Richard Collinson, Ltd., of Corporation-street, Manchester, or from John Heywood, Ltd., Deansgate and Ridgefield, Manchester, and 20–22, Bride-street, London, E.C. 4, price 21s. net. This year's issue forms the fourteenth edition. It contains, amongst a great deal of other information likely to be of use to members of the Exchange or to those having business dealings with them, an alphabetical directory of the firms represented by the members of the Exchange ; an alphabetical list of the members and the firms which they represent ; an alphabetical classification of cotton spinners and manufacturers, cotton doublers, cotton waste spinners and manufacturers, and cotton manufactured goods ; and a classification in towns of cotton spinners and manufacturers, doublers, bleachers, dyers and finishers.

The Status of Naval Engineers.

THE following article from the pen of an eminent journalist and war correspondent appeared in the *Western Morning News and Mercury* on Friday, May 7th, and is reprinted here by the request of some naval officers and by permission of the author.

SNUBBING A GREAT PROFESSION.

AN ANACHRONISM OF NAVAL ADMINISTRATION.

By SIR HERBERT RUSSELL.

There is only one difficulty in connection with making a blunder, and that lies in explaining it. When the Admiralty issued the now famous Fleet Order, very plausibly but very effectually relegating the engineers of the Royal Navy to a lower status, they unwittingly lit a torch —to use the metaphor of the old passive resisters—which they would now give a good deal to see extinguished. For a wholly unforeseen condition has arisen out of that step. With the disciplined protests and restrained resentment of the naval engineers themselves the Admiralty anticipated no difficulty in dealing. The service cannot rise against its over-lords. But the whole vast and honourable engineering profession in this country has made the cause of the naval engineers its own. It has taken up the daggers with a remarkable spontaneity of indignation, because it feels that this professional snub to a class is a slight to the whole. In the language of Mr. Mantalini, this is "demnition awkward" so far as the Admiralty are concerned.

Mr. Bridgeman would receive a good deal more sympathy in the unenviable position in which he has been placed by the action of the Sea Lords if he did not so palpably show his irritation at having to accept responsibility for a blunder which is entirely the work of the silent little community in Whitehall. But when he talks about "puerile" criticism, and "the bad effect on morale" of dissent from this specimen of mandarism he completely gives away the case. The profession of engineering attracts a very high standard of intellect, and in particular it makes for the logical mind. It has based its judgment upon simple facts. When the First Lord inferentially tells the engineering profession that it is incapable of understanding these facts he is merely blowing up the unfortunate torch with great vigour. The glare is now lighting up venerable shadows which those who dwell amongst them would fain have left in secluded dimness. In fact, the engineering profession is directing the national eye upon the archaic conditions which still govern the administration of the British Navy.

The four Sea Lords who are elected to serve as Lords Commissioners of the Admiralty and direct the destiny of that service are officers of the executive branch. They always have been officers of the executive branch, and I think we may readily admit that, as a rule, they have always represented the best brains of their branch. They came into being in the spacious days when the Fleet was manned entirely by seamen, when the term naval officer had no other definition than quarter-deck officer, and when, as Marryat tells us, the highest qualification for command was the ability to club-haul a ship off a lee-shore.

That was all right in its era. It produced a race of men who raised the White Ensign to the world's masthead. But science began to poke her obtrusive nose betwixt the low beams and oak walls of the old three-decker. She was angrily and stoutly resisted by the generation which saw in her prophetic appearance the coming fulfilment of the creed that the service was going to the devil. However, the new-born giantess thrived amazingly at the fostering hands of private enterprise. The old "blowhards" found themselves as impotent against her as Mrs. Partington's broom proved against the aroused Atlantic on Sidmouth beach. They took their pensions and telescopes and watched canvas slowly flicker out beyond the horizon.

UNTOUCHED BY PROGRESS.

But the great transition surged around and past one impalpable condition, leaving it untouched by virtue of its very elusiveness. The tradition of centuries, that only seamen could govern the Navy, remained. The executive smiled at the French proverb, *Autres temps, autres mœurs*. True they could no longer control the ship by braces and halliards, but the fellows below who kept the propellers twirling were but the successors of the mariners who pulled and hauled, and the quarter-deck remained dedicated to officers. Progress in her inexorable march has broken this down. The ship of to-day is the creature of the engineer, and none recognise this more fully than the executive. But the Sea Lords remain sailors. They are imbued with the traditions, the professional prejudices, the hereditary sense of supremacy of their old dominant branch. If this conclusion be challenged, the answer surely may be found in the Fleet Order which, with no justification in the plea of the good of the Service, sharply differentiates the class distinction between the executive and the engineers. It has been a fine *régime*, but it has become an anachronism. The engineering profession of the country, stirred by a sense of injustice, is fanning the torchlight and bidding the nation mark what it reveals. A Navy of steam, hydraulics, electricity continues to be solely governed by Sea Lords. Surely the advent of an Engineering Lord is very much overdue ?

THE first electric railway, the line to Illawarra, Sydney, N.S.W., has been brought into commission. In Melbourne all the suburban lines are electrified, and the scheme has been extended to Lilydale and Fern Tree Gully. In connection with the scheme, each of the three converters already installed at the Prince Alfred sub-station, which is intended to supply power to the other sub-stations in the metropolitan area, will carry a load of about 6000 horse-power continuously and about 13,000 horse-power for brief periods. There are smaller converters also in the sub-station to carry the tramway load in the district which it serves.

K

Alternating-current Pressure Regulators.

No. V.*

REGULATING transformers made by the Swedish General Electric Company, for varying the voltage under load, are connected to a switch which alters the neutral point connection—as shown in Fig. 49. When employing low voltages it is sometimes possible to assemble the transformer and regulating switch in one case, which naturally results in saving in space. The contacts of the switch, which work on the well-known cell regulator principle, are arranged in a circle, over which the switch arms which alter the neutral point connections travel, and resistances are introduced into the circuit as the switch arms pass from one contact to another, so that the circuit is never actually broken. There is also a relay which causes a bell to ring and give warning in the event of these resistances being left in circuit. The arm is shifted over the contacts by a toothed wheel and sprocket arranged so that the contact arm is moved over one complete step for each turn of the sprocket.

The switch mechanism is immersed in oil, and the oil container can be lowered for inspection of the contacts. The regulator is made for hand or electrical operation, by means of press buttons, or for automatic operation by means of a contact voltmeter. Apparatus of this kind has been built for pressures up to and including 66 kilovolts, but for the high pressures the sliding contacts are replaced by contactors operated by a cam shaft placed just below the cover of the oil tank. The apparatus may be built for outdoor use, with a motor contained in a cast iron housing.

As there is a fixed voltage ratio between the alternating and direct-current sides of a rotary converter, induction regulators are sometimes inserted between the transformers and slip-rings of these converters to enable the voltage on the direct-current side to be varied at will, the range of voltage regulation obtainable being greater than that which can be economically secured with the well-known system of reactance control. The regulator increases or decreases the alternating-current pressure applied to the slip-rings, and as in the case of booster control, the power factor is independent of the load and voltage.

Induction regulators may be employed with advantage when the range of voltage required is greater than that which can be satisfactorily obtained with reactance control, when unity or slightly leading power factor is required over a given range of load or voltage, or when voltage regulation is required with the converter running inverted; that is to say, converting direct current into alternating current. Within recent times induction-regulator-controlled rotary converters have been produced with the regulator mounted on the converter itself, an arrangement which economises floor space and is of approximately the same cost as the booster machine. A 3000-kilowatt, 50-cycle rotary converter, designed by the British Thomson-Houston Company, for a speed of 250 revolutions per minute, and fitted with an induction regulator, is shown in Fig. 43, whilst Fig. 44 shows an induction regulator of the same make for a 1200-kilowatt converter. The regulator shown in Fig. 43 is connected between the alternating-current brush-holders and the terminal board of the converter, and there are no external connections to the regulator. Rotary converter sets fitted with these regulators have the advantage that commutation is unaffected by voltage variation, and the converter itself is of the simplest and most robust design. Induction regulator controlled rotary converters are often built by the British Thomson-Houston Company for operating on 95 per cent. leading power factor at full load at any voltage.

* No. IV. appeared May 21st.

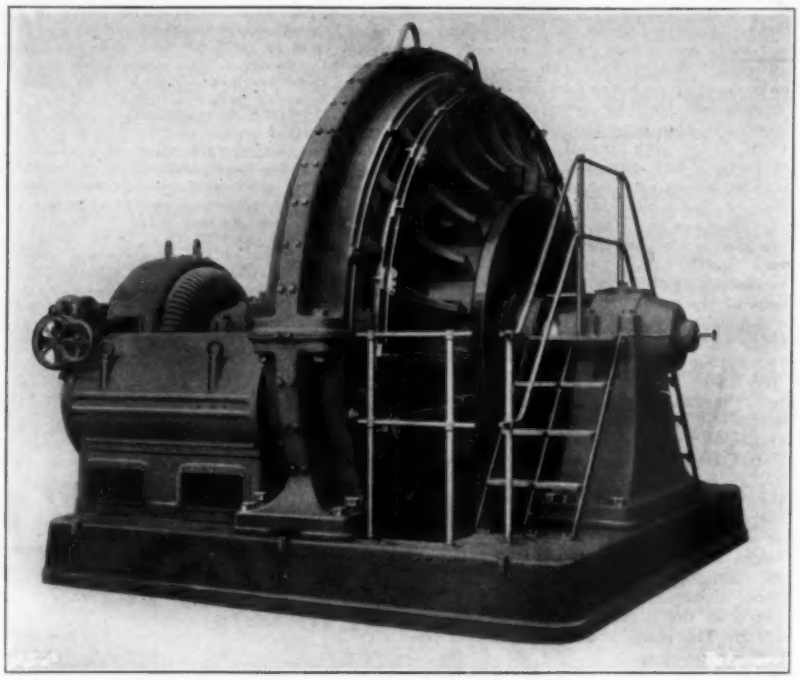


FIG. 43—3000 K.W. ROTARY CONVERTER WITH INDUCTION REGULATOR—B.T.H.

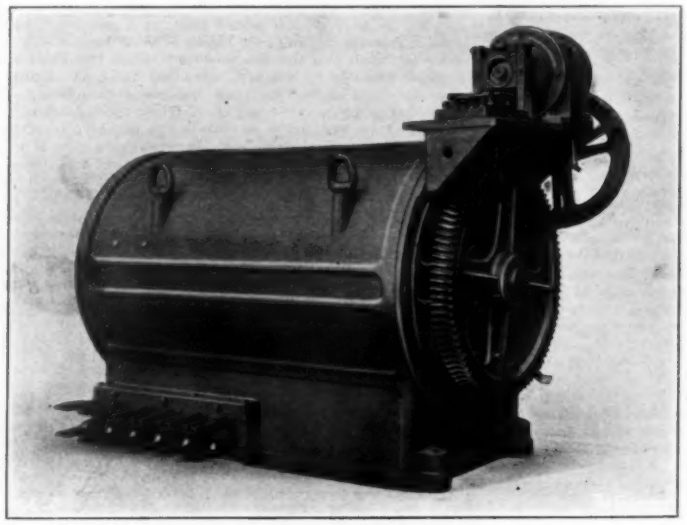


FIG. 44—INDUCTION REGULATOR FOR ROTARY CONVERTER—B.T.H.

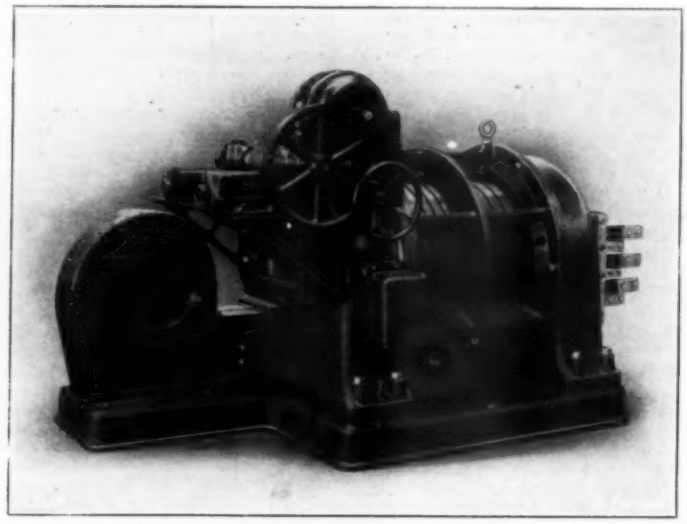


FIG. 45—INDUCTION REGULATOR FOR ROTARY CONVERTER—ENGLISH ELECTRIC

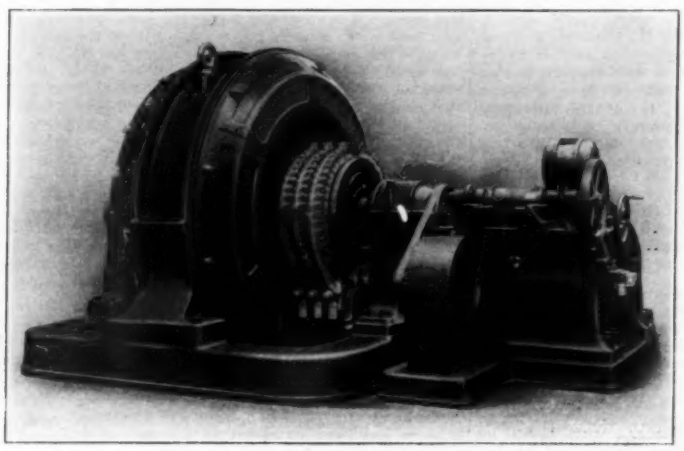


FIG. 46—ROTARY CONVERTER WITH INDUCTION REGULATOR—ENGLISH ELECTRIC

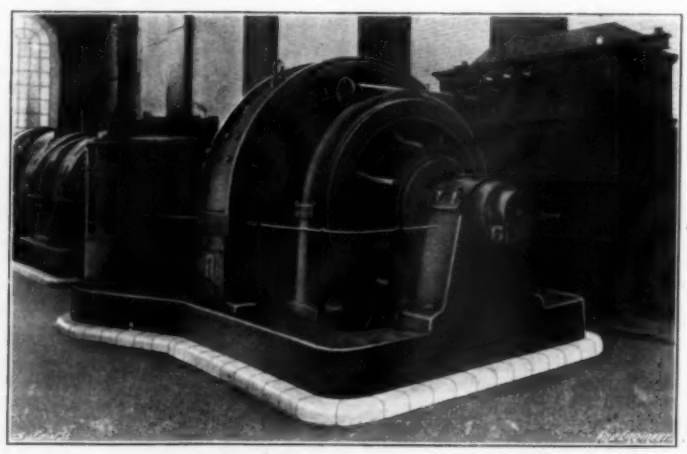


FIG. 47—ROTARY CONVERTER WITH INDUCTION REGULATOR—G.E.C.

The English Electric Company's induction regulator for rotary converters—see Fig. 45—is composed of the usual stationary and movable elements, generally similar to the stator and rotor of an induction motor. The stationary element contains the secondary heavy current windings, which are connected in series between the low-tension side of the transformers and the rotary converter slip-rings, whilst the moving element contains the primary or exciting winding.

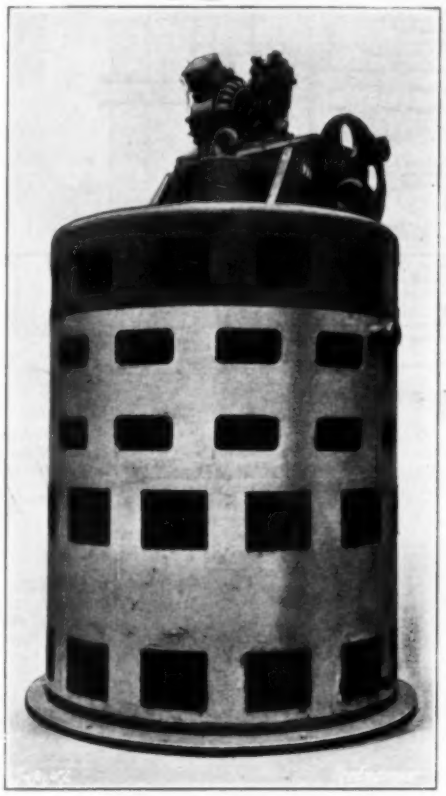


FIG. 46—6-PHASE INDUCTION REGULATOR—METRO-VICK

A Sirocco fan is mounted on the regulator bed-plate, and is driven by a belt from the rotary converter shaft—as shown in Fig. 46. Air is delivered to the hollow casing of the regulator at the operating end, and also through the box bed-plate to the rear end of the casing, and in order to secure uniformity of temperature and freedom from hot spots, all the ventilating passages are proportioned so that a proper distribution of air is

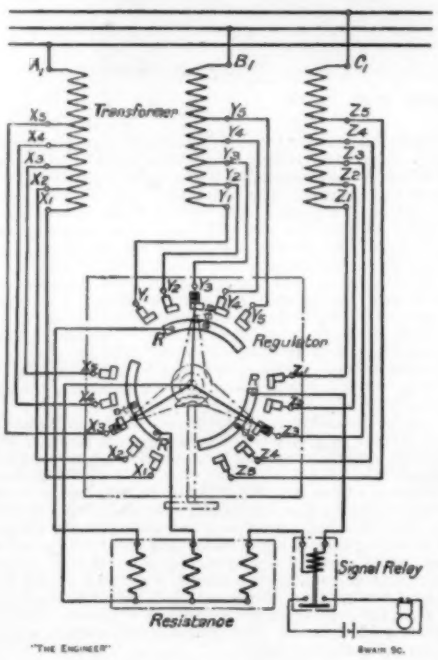


FIG. 49—CONNECTIONS FOR INDUCTION REGULATOR

obtained throughout all the parts of the apparatus. The English Electric Company's regulators are constructed for hand or motor operation. In the former case a simple spur and worm reduction gear is used with a mechanical stop at each end of the travel. When remote control is required, as in the case of power supply sub-stations, motor-operated gear is supplied, with a hand wheel for hand operation if necessary. The operating motor is a totally enclosed three-phase squirrel-cage machine, designed to develop a high starting torque, and it is controlled by means of a small drum-type reversing controller, with a spring return to the off position, and suitable for switchboard mounting. Two double-pole quick-make-and-break self-resetting limit switches are adjusted to break the motor circuit at the maximum positive and negative voltage positions, thus preventing the worm running off the end of the quadrant. Substantial mechanical stops are also fitted as an additional precaution. The motors coupled to these regulators are geared down so as to give an operating time for the complete 90 deg. travel of the regulator quadrant of from 20 to 40 seconds, according to the size of the regulator, these speeds being slow enough to give fine adjustment of the voltage.

To ensure quick stopping of the operating motor when the control switch is returned to the off position, a spring loaded Ferodo-lined brake is fitted to the motor shaft. Induction regulators, made by the English Electric Company, for rotary converter control, are designed for secondary currents, ranging from 350 to 5600 ampères, and are wound either three-phase or six-phase, with four poles. An air-cooled, six-phase induction regulator made by the Metropolitan-Vickers Electrical Company for the control of rotary converters is shown in Fig. 48, the regulator being designed for carrying 3600 ampères and to give a pressure of $\pm$ 30 volts.

The General Electric Company, of Witton, Birmingham, has supplied three induction regulators for the voltage control of rotary converters to the Birmingham Corporation, and, as shown in Fig. 47, they are mounted vertically on the converter bed-plate. The rotor of each regulator is, it may be explained, rotated by means of a small electric motor, which is operated from the switchboard by means of push-buttons, and, as usual, limit switches disconnect the motor if the rotor tends to travel too far. Usually this firm's regulators are cooled by means of a fan driven by a belt from the converter or by a separate motor. Each of the three rotary converters to which the regulators are fitted at Birmingham is rated at 2000 kilowatts, and they run at a speed of 375 revolutions per minute, the pressure being 450 to 512.5 volts.

South African Engineering Notes.

New Bridges.

The new railway bridge built by Mr. R. Monzali, under the supervision of the South African Railways Administration's engineers, at a cost of £92,000, to carry a double line of rails over the Umgeni River (Natal), is now complete and in service, after two and a-half years' work. It is considered to be the finest railway bridge in the Union, and it comprises nine 100ft. spans and two 60ft. spans. It contains about 1400 tons of steel work, and certain of the concrete cylinders forming the foundations are 157ft. in depth below the average summer water level. Much interesting information, both engineering and geological, was obtained during the sinking of these cylinders. The cost mentioned above includes the dismantling and removing of the old temporary wooden bridge, which replaced the original bridge washed away by the great floods of 1917. The new structure has been made specially robust to reduce the likelihood of a similar occurrence in the future to a minimum, and it is anticipated that the hitherto ever-present fears of broken communications with the rapidly developing North Coast of Natal during flood times will now finally disappear.

Seven new bridges, it may be noted, are to be built over the Vaal and Orange Rivers (Transvaal and Orange Free State), the cost of which is estimated at £150,000. These bridges will be for road transport only. The sites on the Vaal River, recommended by the Inter-Provincial Bridges Commission, are Christiana, Greylingsdrift, Scandinavia Drift, Villiers and Klerksdorp. For the Orange River the sites are Roberts Drift and Zastron.

A Durban Ship-repairing Job.

The biggest ship-repairing job that has ever been tackled at Durban Port (Natal) was recently completed on the Swedish steamer Hampholm, which came into port requiring a new propeller, rudder and rudder-post;—a fairly large order. The Hampholm struck a rock at Cape Delgado, on the African coast, last November, and after-some difficulty managed to get to Zanzibar, where she was picked up by a Durban tug and brought to Durban. Since then she has been in the graving dock undergoing repair at the hands of Messrs. J. Brown and Co., engineers, of that city. The engineers found that the vessel's bottom had been so badly damaged as to necessitate the renewal of many plates, frames and a considerable amount of floors, and other repairs. Some of the members had to be taken out, straightened and replaced. In addition, the vessel's sternframe was found to be broken in two places, the lower half of the frame being completely missing, and the rudder bent outwards at about 45 deg. from the vertical. The repairs employed about eighty men in the iron and steel trades for some two and a-half months, and wood-working and other industries have also benefited.

New Railways.

Of the twenty-six new lines of railway sanctioned by the Union Parliament last year, which have a total extent of 960 miles, only two will, it is said, be begun this year. One of them the Addo-Kirkwood line, will be a standard gauge railway serving the Sundays River Valley, in which there is already a population of 6000, of whom half are whites. The line will be 21¼ miles in length, and three bridges will have to be built. The Citrus-White River–Plaston line is the other, and is to be built to develop the White River Valley in the North-Eastern Transvaal. It will be 18 miles long and of standard gauge—light type—and the cost is estimated at £65,394. Apart from these two lines the Railway Administration is completing the first portion of the 91 miles Klaver-Bittefontein Railway to serve Namaqualand, and also the George-Kuysna line, which was sanctioned in the previous railway construction Bill.

Record Workshop Job.

The Pretoria workshops of the S.A. Railways claim to have achieved a record in effecting heavy repairs to a Class 14a 4–8–2 type goods engine. The net time worked on the engine, from its admission until it returned to traffic, was 98½ hours, or approximately 12¼ working days. Under ordinary circumstances a locomotive of the type would take nine weeks to repair. The repairs afforded an opportunity to prove the value of standardisation and of having in readiness spares of the more important parts of a locomotive, such as a complete boiler, motion works, coupling rods, &c. On arrival at the shops the engine was lifted and the wheels removed, the old boiler removed from the frame and the new boiler put in its place. On the boiler being secured in position general routine work of repairs to frame, such as rebushing, &c., was proceeded with. The boring of the cylinders and valve liners was taken in hand by the responsible turner, while another gang got busy with the smoke-box fittings. Amongst alterations to this engine the bissel bogie was fitted with the latest type of gear and an electric headlight was put in position. When the engine was ready for wheeling spare sets of wheels, motion work, piston-rods, crossheads, &c., were utilised each in turn. The connecting-rods off the engine, which had meantime been reconditioned, were also ready for fitting. It may be stated as regards the number of fitters employed on this work that the gang consisted of three erectors, one improver, and two apprentices, the usual complement for one engine being one erector and one improver or apprentice.

Refrigerating Plants.

The enormous increases which are taking place each season in the quantities of deciduous and citrus fruit and grapes has led to the establishment of a 200-ton refrigerating plant at Cape Town docks, designed for pre-cooling fruit preparatory to shipment. In addition to fruit, the exports of meat, butter, poultry, eggs and other perishables is so rapidly increasing that more refrigerating plants will have to be established as early as possible at the collecting centres and ports of shipment. To take only the port of Cape Town, there were shipped during the quarter ended December 31st, 1925, 67,417 cases of eggs, compared with 53,215 cases in the same quarter of 1924; butter, 5134 cases, against 3181 cases; fish, 68,868 cases, against 38,299 cases; and 10,032 quarters of beef, whereas none were shipped in 1924.

Railway Rolling Stock.

During 1925 new locomotives to the number of 118, including 76 electric units, were placed in service on the South African Railways, the estimated value of the whole number being £1,298,615. Forty-seven coaches were placed on the lines, the value being £189,987, while goods vehicles numbered 584, including 400 high-sided (50-ton) steel bogies, the value being £359,271. At the end of 1925 there were 30 steam locomotives and 19 electric locomotive units, representing a value of £558,967, on order or being erected. The types were "Mountain," "Karroo," "Garratt," and modified "Fairlie." Goods vehicles to the number of 1408 are on order and include 1000 bogies for bulk grain. Their estimated cost is £975,975. At December 31st, 1925, there were 161 main line saloons, 285 suburban coaches, and 34 miscellaneous types of carriages under construction in the Administration's workshops, or on order from overseas, the total estimated cost of these vehicles being £2,178,801.

Municipal Enterprises.

Work on the municipal power station extension at Johannesburg is now proceeding. The new building will house a 10,000-kilowatt generating set, two boilers and a pumping plant, with all accessories. The erection of the machinery will begin shortly, so that it may be moving about September. The same municipality, it is understood, has had the sanction of the Administration to its proposals to spend £300,000 on a new gasworks and reticulation system. The Durban Town Council is applying shortly for power to borrow £775,000, of which £350,000 will be expended on electric supply; sewerage, £125,000, and storm water drainage, £250,000. The Queenstown Town Council is spending about £30,000 on an entirely new power station and equipment. Moorreesburg has called for tenders for an electricity undertaking, while Dordrecht has ordered plant for its electric lighting scheme, and Stutterheim is considering the provision of an electricity undertaking.

Mineral Production.

The total value of the mineral production of the Union of South Africa for the first two months of 1926 was £8,841,690. Gold accounted for £6,598,718, diamonds for £1,429,859, coal for £590,602, copper for £83,536, tin for £56,325, silver for £21,386, osmiridium for £20,736, and other minerals for £40,528. The platinum produced is not yet included in the returns furnished by the Government Mining Engineer. The figures obtained from other sources give the quantity at about 684 oz. and the value about £16,414.

ACCORDING to a prospectus which has just been issued by the Birmingham Chamber of Commerce, the British Industries Fair next year is to be held from February 21st to March 4th, in the usual buildings at Castle Bromwich. The Government is again subscribing £25,000 for the purposes of publicity.

Valves for the Fourth Thirlmere Pipe Line.

THE laying of the fourth line of pipes completes the aqueduct between Lake Thirlmere and Manchester. The line of aqueduct comprises 13 miles 1410 yards of tunnels, 37 miles 1219 yards of covered channel, and of the four lines, the pipes measure 44 miles 495 yards in the cases of the first two and 54 miles 891 yards in the cases of the third and fourth, the total length of aqueduct to Audenshaw being 106 miles. The fourth line consists of twenty-nine syphons having an aggregate length of 32 miles, these syphons being controlled by valves at each end. On the longer syphons there are also manual sluice valves, reflux valves, automatic stop valves and double ball air valves, all of which were designed with the latest improvements by the makers, J. Blakeborough and Sons, Ltd., Brighouse. By permission of Mr. L. Holme-Lewis, M.Inst.C.E., M.I.Mech.E., waterworks engineer to the City of Manchester, we are enabled to place before our readers an illustrated description of all these appliances.

AUTOMATIC SELF-CLOSING VALVES FOR NORTH AND SOUTH WELLS.

Automatic self-closing valves are necessary where aqueducts change from one form to another, such as from a tunnel or covered channel to piping or *vice versâ*. In the fourth line valves of this kind have been provided at the north end of the syphon, where the water passes from the tunnel, or cut and cover, to piping, while at the south end of the

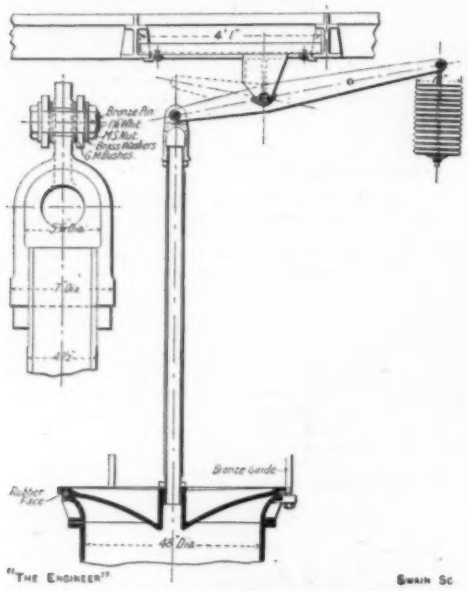


FIG. 1—OUTLET VALVE FOR SOUTH WELL

syphon there is a well for passing the water again through self-acting outlet valves into the cut and cover or tunnel. The north well valves act automatically to stop the forward flow of the water in case a fracture takes place in the syphon south of the well. The syphon well or chamber receives its supply of water from the valve chamber, the connection being by means of a cast iron waterway built into the concrete which forms the floor of the chamber—as shown in the illustration, Fig. 3. The end which admits water from the concrete aqueduct is fitted with a gun-metal seating, and over it is suspended a steel cylindrical valve, the dropping of which stops the inflow of water to the syphon. The other end of the cast iron waterway is the outlet for the water into the syphon chamber. The self-acting valve is so constructed that in the event of the velocity of water through it increasing by 15 per cent. above the normal speed it will, by means of a system of duplex floats and trip gear, close automatically, provision being made by means of a dashpot to allow the valve to fall at a decreasing rate so that it may seat without shock. The dashpot is filled with glycerine and is provided with a by-pass for the discharge of fluid from one side of the piston to the other, and there is a needle valve for regulating the time of closing, which is not to be less than one minute or more than three minutes. To prevent the full rush of water into the pipes again, when the valve is reopened, an arrangement of resetting mechanism is provided, to ensure that the water shall pass into the pipes at a moderate and safe speed. It consists of a fine-threaded bronze spindle actuated by a hand-wheel with a gun-metal revolving nut and on the end of the screwed spindle a gun-metal roller is fitted for pressing down one end of the lever for resetting the valve. To this spindle is fitted a pointer, and on the web of the standard is an index plate marked "Reset" and "Charge" with the time stated for filling the syphon pipe. The action of the valve is as follows:—When the flow of water through the syphon is increased above the normal the extra flow through the cylindrical

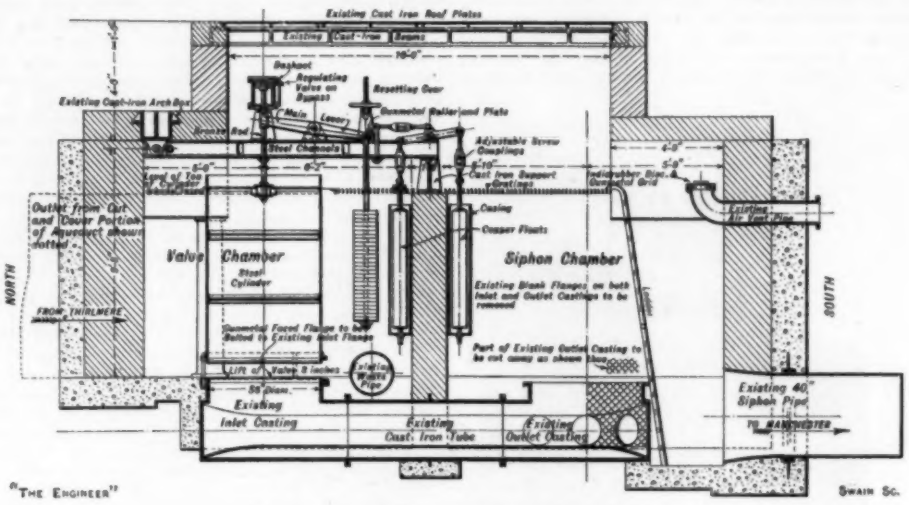


FIG. 3—SELF-ACTING VALVE FOR NORTH WELL

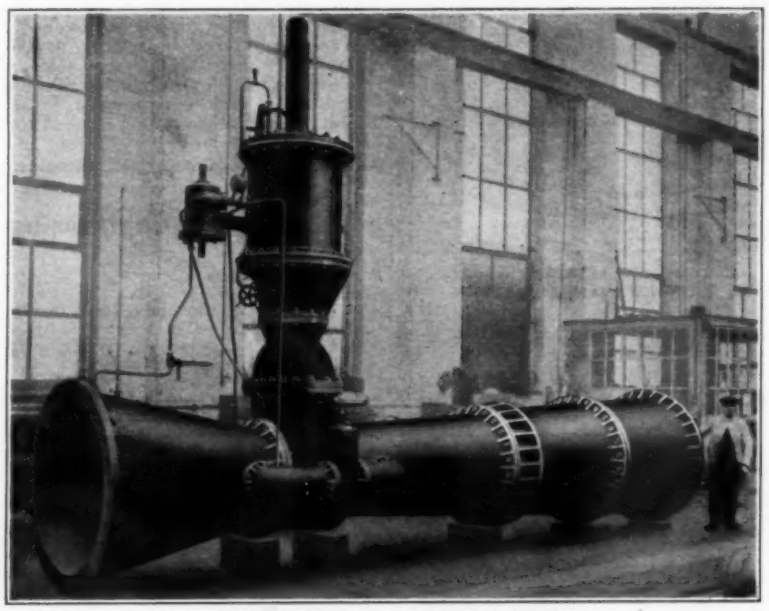


FIG. 4—EDWARDS' AUTOMATIC STOP VALVE

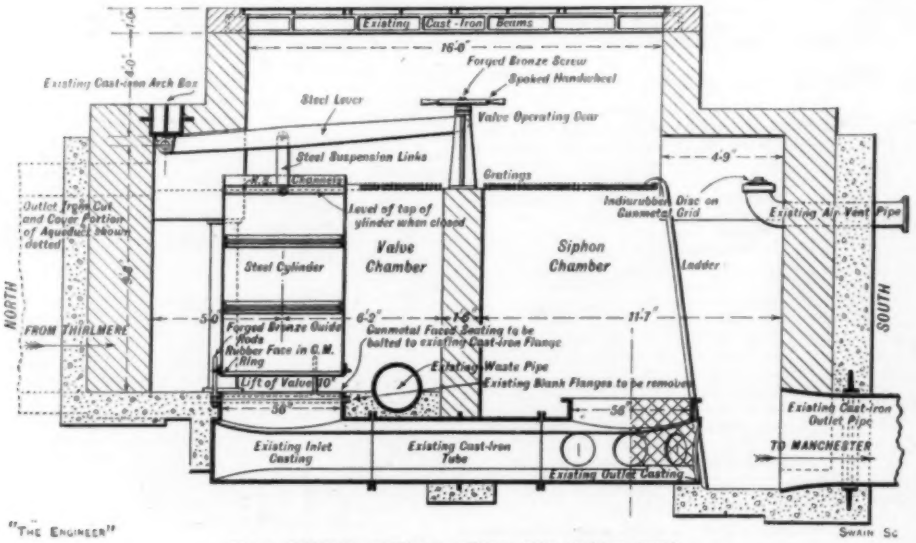


FIG. 2—MANUAL CYLINDER VALVE FOR NORTH WELL

The minimum difference in water level between the valve and syphon wells necessary to release the trigger lever can be adjusted at each syphon by means of the weights on the float in the valve well. The inlet of these self-acting valves is 58in. diameter. The steel cylinder is made in three sections, each section being so designed that it will pass between and without disturbing the cast iron girders which carry the roof plates of the well. The pivots for the main and float levers are carried in Hoffmann ball journal bearings, and a roller journal bearing, with suitable protection against atmospheric and weather conditions. At all points where rubbing is likely to occur gun-metal rollers are fitted. To the lower edge of the cylinder 2½in. by 2½in. by ½in. angles are electrically welded, the lower face being machined and drilled for the purpose of attaching thereto a gun-metal ring fitted with a rubber face, which closes down upon a gun-metal face secured by means of countersunk bronze screws to a cast iron flanged seating ring. This seating is bolted to the flange of the inlet casting in the bottom of the well. Vertical bronze guide bolts are provided to ensure correct seating of the valve on the ring.

OUTLET VALVES FOR SOUTH WELLS.

At the outlet end of each syphon the water enters through a vertical bell-mouth pipe over which is suspended a cast iron disc by a link from a counter-weighted rocking lever, which is hung from the roof of the chamber—as shown in Fig. 1. The reaction of the upward flowing stream of water lifts the disc from its seat and it remains suspended, but should there be a burst in the syphon causing the upward flow to cease, the disc seats itself automatically and prevents the water in the chamber, brought in by the other pipes, from flowing back into the syphon. The valve seating is of gun-metal secured to a cast iron

of the float moves the trigger lever so as to move the tipping lever. The latter is held in position by mild steel links attached to the steel channels which carry the cylindrical valve and gearing. The valve then tips and, in doing so, withdraws the roller from the end of the tipping lever, thereby setting free the mild steel main rocking lever. The rapidity of descent is regulated by the needle valve as previously described.

bell-mouth resting on and bolted to the flange of a cast iron pipe built in the concrete floor, and the disc has a rubber face where it closes down on to the gun-metal seating ring. To keep the door in position laterally, three forged bronze guide rods are provided, and are bolted through the lugs on the top of the flange of the bell-mouth pipe.

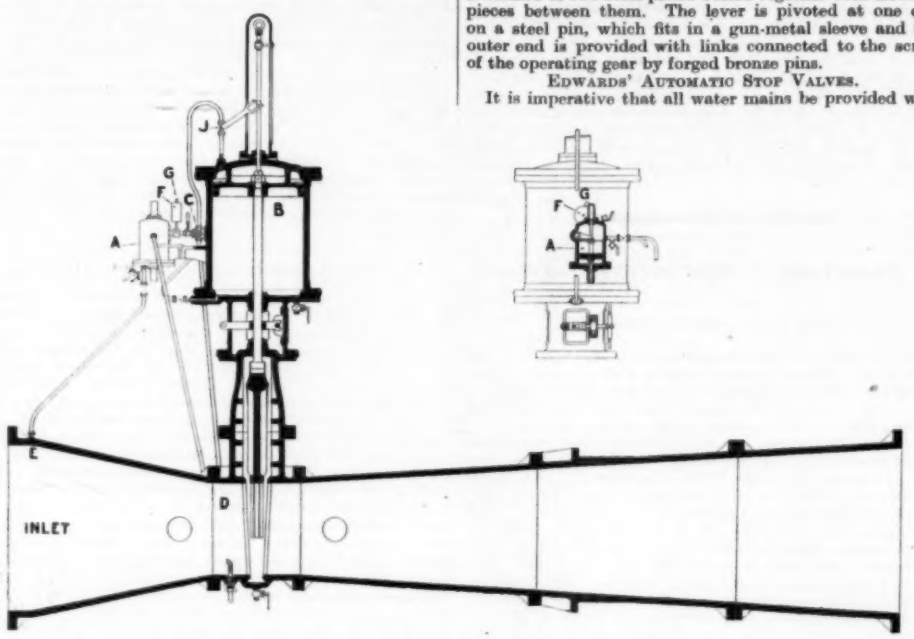


FIG. 5—ARRANGEMENT OF EDWARDS' AUTOMATIC STOP VALVE

FIG. 6—SECTION OF 6in. AIR VALVE

On some of the short syphons the cylinder valves are operated manually, instead of by means of the automatic float gear, as the risk of a burst and consequent damage is negligible, the pipes being made of steel. These valves —Fig. 2—are actuated by a hand-wheel and screw connected with a lever. The valve body is formed of a steel cylinder with a gun-metal facing ring, and closes down upon a flanged seating ring of the same metal. The valve is suspended from the lever by steel links, and the lever is formed of two steel plates bolted together with distance pieces between them. The lever is pivoted at one end on a steel pin, which fits in a gun-metal sleeve and the outer end is provided with links connected to the screw of the operating gear by forged bronze pins.

EDWARDS' AUTOMATIC STOP VALVES.

It is imperative that all water mains be provided with effective automatic closing valves which, in the event of a fracture of the main from any cause, will isolate the damaged section. Such valves are generally interposed before any length of inverted syphon, or at points in the main where it is essential to prevent flooding from the effects of a burst. Edwards' patented automatic closing valve —which is illustrated in Fig. 4 and in the drawing Fig. 5—is expressly designed for this purpose, and acts on the Venturi principle, the Venturi head, *i.e.*, the difference in pressure between the inlet and the point of maximum constriction being utilised to actuate a trip mechanism, which can readily be adjusted to come into operation at any predetermined rate of flow. In other words, should a burst occur in the main the increased velocity of the water through the valve is utilised for operating the closing mechanism. The closing action takes place quickly during the first three quarters of the travel, but is retarded in the final stages to prevent concussion. It will be seen that the main valve is of the double wedge sluice type, and has gun-metal faces on both the body and the plug. The sectional illustration—Fig. 5—shows the valve open. When the valve is set, for action to operate at any predetermined rate of flow the space above the piston in the small cylinder A is in direct communication with the throat D of the main valve, while below the piston the full pressure in the main at E is operative. There is a difference between these two pressures due to the rate of flow of the water, and when this difference reaches the predetermined value at which the mechanism is set to close the valve, the weight F on the lever G is no longer able to hold the piston in the cylinder A at the bottom of the stroke. The fall of the weight reverses the four-way cock C, with the result that the full main pressure is applied to the top of the piston in the cylinder B, and the exhaust at the lower end is fully opened. The descent of the piston follows, and continues to increase in speed for a time until the closing of the cock J, which is operated by a pin on the tail-rod of the piston, retards the motion. During the last quarter of the stroke the speed of the movement is gradually reduced until the point of complete shut-off is reached. To reset the mechanism the pressure of water on the two sides of the main valve is first equalised by opening the by-pass, and then the lever controlling the motion of the four-way cock C is pulled over to its original position, and is followed by the upward motion of the piston in the cylinder B under the action of the hydraulic pressure below it. The main valve is thus re-opened and the piston in the small cylinder A is forced to the bottom of the stroke, the weighted lever G holding it in position as long as the pressure difference due to the rate of the flow does not exceed the critical value.

When it is desired to change the rate of flow at which the valve will operate, the weight F is raised on its lever for an increase and lowered for a decrease. By the calibration of the lever G a scale may be obtained for the position of the weight F for any desired flow. For inspection purposes the valve may be held open indefinitely by means of a friction clutch which grips the spindle of the main valve. The bore of the main employed on the Thirlmere

FIG. 9—54in. REFLUX VALVE

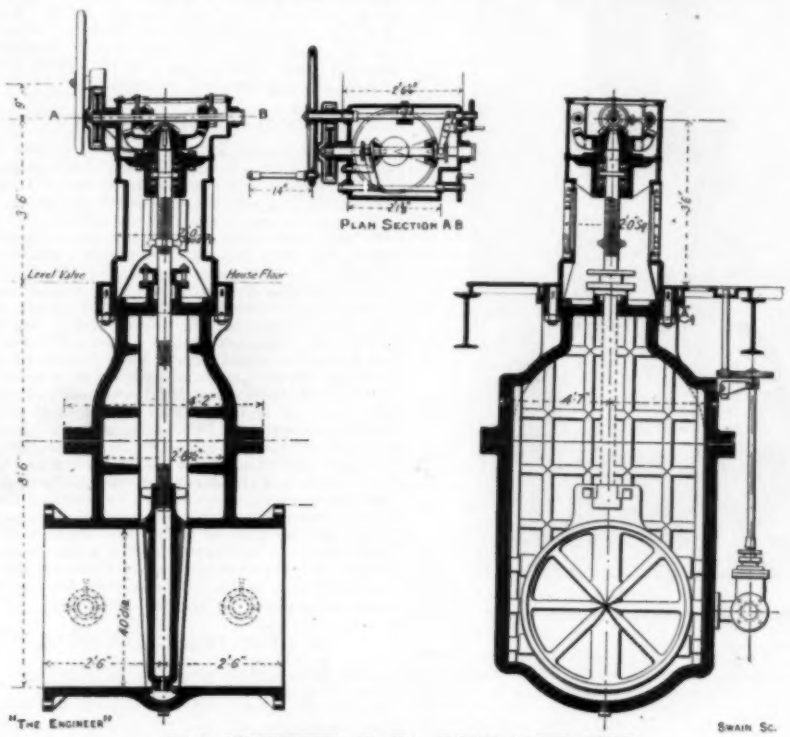


FIG. 8—ARRANGEMENT OF 40in. MANUAL SLUICE VALVE

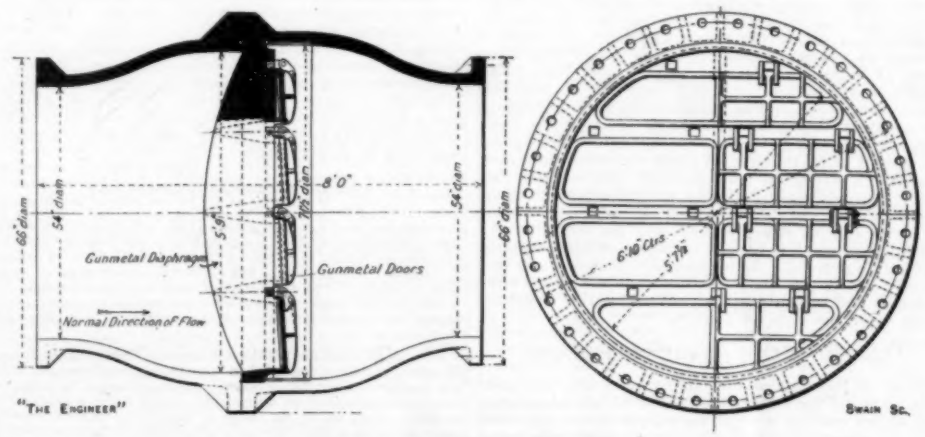


FIG. 7—54in. REFLUX VALVE

scheme is 54in., this being reduced to 30in. at the valve or point of maximum constriction.

MANUAL SLUICE VALVES.

The drawing—Fig. 8—shows in sectional detail one of the 40in. manual sluice valves supplied by Messrs. Blakeborough. It will be seen that the valve has one door with two wedge faces, and the door is opened and closed by means of a screw working in a nut fixed in the door. The spindle is carried through a gland to a double ball bearing in a headstock, and can be operated by a hand-wheel through either quick or slow gearing by one man. The gears are of spur and bevel types made of cast steel and machine cut. It will be noted that the headstock is constructed so as to give ease of access to the gearing and ball bearings, and that provision is made for lubrication. Hinged doors with strong glass panels are fitted in the sides of the headstock. The valve body is of strong construction, and has branches and bends for connecting to the 4in. by-pass sluice valve. The screw spindle, gland bolts and pins on which the guide rollers work are machined bronze forgings and the faces of the body and door of the valve, guide rollers, nut for the screw spindle are also of bronze. A general view of one of these valves is given in Fig. 10.

AIR ESCAPE VALVES.

For the purpose of releasing large quantities of air when the water main is being charged and for the escape of air which afterwards accumulates under pressure, self-acting air-release valves are fitted at the high points on the line of main. Air valves are usually of two kinds—i.e., single-acting and double-acting, the latter having two outlet chambers with balls, one of which lets out the large amount of air when the main is being charged, the other acting

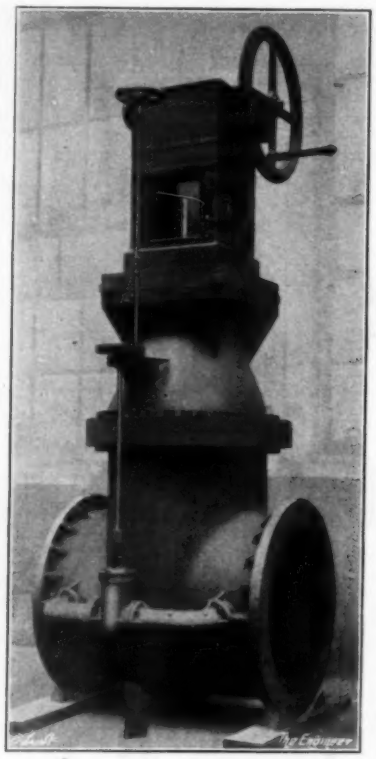


FIG. 10—40in. MANUAL SLUICE VALVE

under pressure and allowing the escape of air which accumulates afterwards. These air valves are constructed on the principle that the weight of the ball must be sufficient to overcome the upward force acting upon the area of the orifice on which the ball bears due to the pressure of the air or water in the main.

The air valves—Fig. 6—are of an improved pattern and are 6in. bore, the body, valve covers and dirt covers being all of cast iron. Each valve has two floating balls 6½in. diameter in cast iron pockets, and so guided that when the valve is fully charged with water they press against the ball seats. These two seats are of different diameters, the smaller one being designed to permit the escape of any air which may accumulate in the valve chamber and then close again. The larger valve remains open while the syphon is being charged, but closes and maintains an air-tight joint when the charging operation is complete. To enable the balls to be isolated from the syphon the inlet is fitted with a mushroom valve, as shown. This is 6in. diameter and is opened and closed by means of a screw spindle. The balls are made of wood covered with ebonite to a sufficient thickness to give them a weight such that, when floating in water, they will be submerged for fifteen-sixteenths of their circumference. The seatings for these balls are of rubber, the larger one having a leather pad between it and the gun-metal bush in the cover. The seating of the smaller valve is in a gun-metal nipple, which may be withdrawn without closing the mushroom valve owing to the ball making a reasonably tight joint against a gun-metal ring.

To allow the valve chamber to be emptied of water when the mushroom valve is closed a ¼in. screw-down tap shown is fixed into the side of the valve chamber. To bring the air valves level where the main is inclined and to raise them to the correct height above the surface of the ground cast iron flanged lengthening pipes of an average length of 2ft. are provided.

REFLUX VALVES.

A sectional view of one of the 54in. reflux valves is shown in Fig. 7. The body of the valve is of cast iron in two sections, bolted together and having machined flange joints with gutta-percha rings. The section on the inlet side is fitted with a heavy gun-metal diaphragm and that on the outlet side with a gun-metal bush. The object of this bush is to prevent possibility of fouling the valves by pieces of rust which may form in the body. Five gun-metal doors are provided, and these are hung on double hinges on the diaphragm so as to open easily on a horizontal axis The hinge eye studs and hinge bolts are of forged bronze, and the hinges are of gun-metal. The slope of the doors is the same in each case, namely, 3½ deg. to the vertical, with the top edge of the face 1in. from the plate. A general view of one of these valves is given in Fig. 9.

American Engineering News.

LARGE LOCOMOTIVE TERMINUS.

The extensive improvements to the Chicago terminal lines of the Illinois Central Railroad include engine-house facilities for the large number of local and shunting engines. Six tracks leading to the engine-house pass first a 1200-ton coaling station, which serves all the tracks, and then converge into four tracks, two of which pass over the cinder pits for cleaning out fire-boxes, while two lead around the pits to the turntable, 100ft. in diameter. This is not a balancing table, but is of the three-point bearing type, the weight not being all carried by a central pivot. This turntable is at the centre of an annular engine-house or roundhouse, which has 48 stalls or engine tracks, and is almost a complete circle, broken only by the four lines of rails converging towards the turntable. This building is 125ft. wide, and its outer wall has a radius of 240ft., leaving a space 65ft. wide between the building and the turntable. Three of the engine-house tracks extend into an adjacent machine shop and boiler shop for repair work. Each track has a pit for inspection and repairs of motion, while drop pits in certain tracks provide for removing driving wheels and engine bogies. A separate building contains the equipment for washing out locomotive boilers with hot water. There are two large steel tanks and two circulating pumps, one for washing out and the other for refilling the boilers. Other facilities include water tanks for tender supply, sand drying and supply, power station, and rest or welfare building for the use of enginemen and shopmen.

FERRO-SULPHUROUS BLAST-FURNACE.

Ferro-sulphurous alloy is produced mainly in electric furnaces, but there is one American blast-furnace operated for this purpose under the patents of Mr. J. J. Gray. The original furnace was dismantled and replaced with a larger one about the end of 1925, the latter being 70ft. high with 12ft. hearth and 16ft. bosh; it is 12½ft. in diameter at the stock line, with a charging bell 8½ft., surmounted by a small revolving hopper and bell of 4ft. diameter, into which the skip dumps its charge. Special construction is required to prevent the escape of phosphorus during the smelting process. The hearth and the tuyere jackets are of cast iron, each in eight sections, put together with machined joints, and secured by forged steel links shrunk over lugs on the jacket sections. Gas is drawn off from the furnace through two 4ft. downcomers, which are lined with firebrick and extend to a brick-lined dust catcher 12ft. in diameter and 16ft. high. Beyond this is a washer for further cleaning of the gas. The charging skip, of 60 cubic feet capacity, is operated on an inclined track by a cable and counterweight, and is charged from an electrically-operated scale car. The furnace top is fitted with a revolving distributor, having a worm and gear drive running in an oil bath. This drive, with its motor and brake, are supported from a spider casting, which maintains it in proper alignment. There are also the usual bell-operating mechanism, auxiliary devices and a jib crane for handling the large bell and hopper.

ELECTRIC EXCAVATORS.

Complete electrification of its excavating plant is planned by the Utah Copper Company, of America, which has already substituted nine electric shovels for steam shovels, but has still fourteen steam shovels in operation for removing overburden and open mining of the ore in great continuous cuttings. One great advantage is in reducing the trouble and expense of distributing coal and water all over the workings, the consumption in 1924 being 104,615 tons of coal and nearly 240,000,000 gallons of water. The standard electric shovel has a 4½-yard bucket or dipper, and is mounted on caterpillar tractors, its total weight being about 100 tons. The machines work in echelon on a series of benches in the face of the hill or slope. Transmission-line current at 44,000 volts is delivered to the sub-stations and converted to 5000-volt current distributed over two parallel lines extending around the mining area and having a length of about five miles. Taps are taken off to the benches through switch houses, the current being transmitted along the benches by overhead wires carried on portable steel towers about 25ft. high. Both alternating-current and direct-current equipment is used. The output of material excavated is about the same as with steam shovels, but the labour cost is about 24 per cent. less, and the saving in operating material is about 80 per cent. It is expected that there will be a material saving in maintenance cost, while the absence of smoke and steam is an advantage for the numerous trains which serve the excavators.

LEACHING LOW-GRADE COPPER ORE.

Trials of leaching copper out of low-grade ores piled in heaps at the Sacramento Hill Works in Arizona, indicate that 25 per cent. or more of the copper can be recovered from ore of less than 1 per cent. content, at a cost approximating 2¾d. per pound. Nearly 2,000,000 tons of ore containing about 16,500 tons of copper, were deposited by large side-dump railway wagons on sloping ground having an approximately impervious surface. The larger blocks of ore were used to form culverts through the heap, which is from 6ft. to 30ft. deep and covers an area 750ft. by 1800ft. The top is formed in a series of shallow basins, 25ft. square, which are filled with water, the water gradually seeping through the heap and leaching out the copper. The drainage from the culverts is led to a storage reservoir, and thence pumped to the cementation works for extraction of the copper. With a supply of 300,000 gallons of mine water daily, about 50,000 gallons are absorbed by evaporation or by soakage, which is the water taken up by the ore. A recovery of 70 per cent. is estimated for a period of six years, of which 20 per cent. occurs in the first year. The cementation plant consists of wooden tanks, 24ft. in diameter and 10ft. deep, having a double bottom filled with scrap iron, through which the leached liquid passes upward into each tank in succession. The final waste water is collected and pumped to the leaching heap again.

RAILWAY LABOUR-SAVING MACHINERY.

With the decreasing supply and increasing wage cost of common labour during recent years, American railways have made great advances in the use of mechanical labour-saving appliances. Thus in spite of increasing traffic and wheel loads, the number of man-hours per year per mile of track has decreased about 5 per cent. on the New York Central Railroad. Roadway drainage ditches are cleaned out periodically by ditching machines of the scraper-blade or steam excavator type, where formerly large gangs of men would be employed. Packing of sleepers is done by electric and pneumatic machines. Rail anchors prevent creeping and so reduce the shifting and re-packing of sleepers. Motor cars or lorries carry the men to and from work, thus conserving their strength and energy for normal railway work. Screw spikes are driven, rails drilled and sawed and fish-plate bolts applied and removed by pneumatic and electric devices. Other machines clean the ballast, dress it to shape, place and remove rails, mow grass, or destroy all weeds and grass in ballast by chemicals, oil flame or steam. Locomotive cranes perform a variety of duties that formerly required gangs of men, such as loading, unloading and stacking rails and sleepers, renewing rails, and placing points and crossings. Painting is done by spray machines and fish-plates, and bolts are oiled periodically by oil-spray machines.

SIXTY YEARS AGO.

SIXTY years ago the best apparatus available for obtaining powerful electric currents was a Grove's battery. It was, however, very expensive to work, troublesome to keep in order and suffocating in the fumes which it gave off. It is easy therefore to appreciate the importance and interest at once excited by the disclosure to the Royal Society by Faraday of a new principle for the generation of powerful electric currents. Under the heading "A Splendid Discovery in Electricity," we published a summary of the veteran philosopher's paper in our issue of May 11th, 1866. The discovery and the machine whereby it was demonstrated were the work of Mr. H. Wilde, of Manchester. Magneto-electric machines, or, as we would now describe them, dynamos with permanent magnets, had been in practical use for some little time. Wilde's discovery consisted of the revelation of the fact that if the current produced by a magneto-electric machine were employed to energise the electro-magnets of a second machine without permanent magnets, a greatly increased quantity of dynamic electricity was obtained as compared with that produced by the magneto-electric machine alone. Ultimately, Wilde constructed a machine weighing 4¼ tons, consisting of one magneto-electric machine in series with two electro-magnetic machines. With this apparatus "a current of extraordinary power" was obtained, and "quantities of electricity far exceeding that hitherto obtainable by any other form of machine were given off." We certainly realised the importance of the discovery, but, quite excusably perhaps, we seem to have failed to grasp its true principle. Had we done so we would hardly have suggested, as we did in a leading article in the same issue, that it now seemed possible to make a little machine with a heavy fly-wheel out of which a small boy could grind vast quantities of electricity as fast as required. . . . In an article on the Lenoir gas engine in our issue of May 18th, 1866, an unfortunate misprint must have bewildered many of our readers as to the mode of action of that then but recently introduced source of motive power. Describing the cycle, the article stated that "when the piston has moved through a little less than half the stroke, the valve closes and an electric spark is introduced into the cylinder and drives the gases. The expansion caused by the heat of combustion ignites the piston during the remainder of the stroke." The words "drives" and "ignites" began two successive lines, and had been transposed in the composing room. To us, the misprint is obvious, but in those days when the internal combustion engine was still an experimental novelty, not a few of our readers unacquainted with its principle would from our article probably come to a quaint conclusion as to M. Lenoir's sanity.

CONGRESS FOR APPLIED MECHANICS.—An International Congress for Applied Mechanics will be held at the Federal Technical University, Zurich, from September 12th to the 18th. Professor E. Meissner will be glad to receive the names of those who propose to attend. The titles and an abstract, not exceeding 300 words, of any paper offered for presentation at this meeting should be forwarded to him at the University not later than June 1st.

TWO-BODY SELF-DISCHARGING WAGON.—The Cambrian Wagon Company, Ltd., of Cardiff, has recently patented and put upon the market a new type of railway tipping wagon. It comprises two bodies mounted on a main-line wagon frame supported on rockers, which are in the shape of quadrants with the vertical sides at the back, the other sides being fixed to the bottom of the wagon bodies. A feature of the design is that it is possible to tip the bodies at three different angles, so as to make the tip suitable for any class of material. No mechanical power is required to tip the bodies, it being, so we understand, quite easy to pull or push them by hand to the original horizontal position. The capacity of each of the bodies is 190 cubic feet.

Railway Matters.

DURING the foggy weather last November the London, Midland and Scottish Railway exploded as many detonators as had been done in the whole of the preceding three years.

THE Baden State Railway Council is urging the German State Railway authorities to take in hand without further delay the electrification of the railway between Frankfort and Basle.

THE "Proceedings" of the Institution of Railway Signal Engineers for the second half of the session 1925–26 contain three interesting papers and the discussions thereon. They are "The Ministry of Transport Requirements for New Railways," "The Working of Points and Signals by Wire," and "Long-burning Signal Lamps."

THE provision of first-class accommodation is often regarded by many as an extravagance and quite unnecessary. As it appears that the first-class receipts on the London, Midland and Scottish Railway average £23 15s. per first-class seat per year, as compared with £25 per third-class seat per year, the necessity for first-class accommodation appears to be proved.

ONCE again the Swiss Federal Railways have had to take into account the fact that birds can do damage to electric railways. In the canton of Valais the hawks have discovered that the top of a high insulator forms a capital observatory for surveying the land below, and having perceived their prey dash down upon it from the insulator. The result is that their wings touch the live wires and cause a short circuit, at the same time electrocuting the unlucky hawk.

THE track of the Manchester Corporation tramways has increased since the war by 34 miles, making the total 237 miles. The cars have increased by 195 to a total of 1000. A considerable portion of the new tramway along Kingsway, Manchester, has been laid, and it is hoped that within twelve months a tramcar service will be available along the whole route from Levenshulme to the junction of the thoroughfare with the Wilmslow-road. Sleeper construction has been adopted.

THE retirement, on June 30th, is announced of Mr. John Bagwell, the general manager of the Great Northern of Ireland, which position he has held since October, 1911. Mr. Bagwell went through some painful experiences during the recent dark days in Ireland; he was kidnapped once, and, on another occasion, his house was burnt down and many valuable papers, collected by his father, relating to the history of Ireland, destroyed. The new general manager will be Mr. J. B. Stephens, the secretary and assistant general manager.

THE annual report of the Canadian National Railways for 1925 shows an operating revenue of 244,971,202·61 dollars, and operating expenses of 212,706,787 dollars, leaving a net operating revenue of 32,264,414 dollars. This is an increase of over 15,000,000 dollars in the net operating revenue, as compared with last year. This substantial improvement renders possible a further reduction in the net income deficit of the railway, which had been reduced from 54,860,419 dollars, at the end of 1924, to 41,444,764 dollars at the end of 1925.

DESPITE the strike and coal stoppage the Southern Railway intends to carry out that part of its electrification programme which, as related in this column on February 12th, was arranged to be begun on Sunday week, June 6th. The services between Charing Cross and London Bridge and Dartford, *viâ* Woolwich, Bexley Heath and Sidcup, will be opened on that date, but, owing to the coal stoppage, the service may be less frequent than was intended. At 3 p.m. to-morrow—Saturday—week Cannon-street Station will be closed for three weeks to allow the lines and connections in the yard to be rearranged and the new all-electric power signalling installed.

ON November 20th last, during the prolonged spell of foggy weather at that period, a collision occurred between two passenger trains at Wincobank North Junction on the Midland section of the London, Midland and Scottish Railway. The fog was so dense that the signalman had the assistance of a groundsman, who, because one of his duties was to see that each passing train had a tail lamp, was known as a tail-lamp-man. An up and a down train had passed, and then a second up train was signalled. There was a misunderstanding between the two men as to the up trains, and the second which had not passed was irregularly cleared. To prevent any such mistake, Major Hall, in his report on the collision which resulted, recommended that the tail-lamp-man should have a watch so that he could identify each train by the time it passed. Speaking of the difficulties under which operations are carried out in such dense fogs, the inspecting officer added: "It is, I think, due to signalmen and others generally to remark upon the high degree of security which is in general attained under these very adverse conditions, as a result of the care and attention to duty which is shown by the men concerned."

DURING the strike the block system necessarily was suspended. In some cases, where tunnels intervened for instance, communication was kept up by telephone. Such conditions prevailed between St. Margaret's and Portobello West boxes, Edinburgh, London and North-Eastern Railway. On the afternoon of Monday, May 10th, some wagons were being shunted at the former box when they were run into by a down passenger train and three passengers were killed. The facts were inquired into by Colonel Sir John Pringle on May 12th, and until his report appears it is undesirable, owing to the fatalities which resulted, to discuss whether or not permission was given for the passenger train to approach. Sir John subsequently inquired into the derailment on the same, Monday, afternoon of an up East Coast express at Cramlington. In that case a rail was apparently maliciously removed, but there were no serious personal injuries. At Bishops Stortford, too, there was a collision in which a passenger waiting for the train was killed. That was not a fatal train accident in the usual meaning of that term. The accident at Edinburgh was the first fatal train accident since June 14th, 1925, and the first in which more than one life was lost since November 3rd, 1924.

Notes and Memoranda.

IN a pamphlet, entitled "Lessons from the Fire in the Argonaut Mine," published by the American Bureau of Mines, it is stated that a man working for some time in a fire atmosphere that does not affect a candle flame and may not overcome a canary bird can accumulate in his blood enough carbon monoxide, if it is present even in minute quantities, to make him violently ill. Many men working in the Argonaut shaft and later in the 4350 level, where neither canary bird nor candle were affected, developed severe headaches and vomited. The atmospheres undoubtedly contained small percentages of carbon monoxide.

AMONG the protagonists engaged in the scientific struggle concerning the existence or non-existence of the ether must now be numbered Professor Miller, an American research worker, who has just stepped into prominence with the assertion that the ether does exist. Professor Miller, who carried out his experiments in the Mount Wilson University, California, states that he transmitted light waves from one point to various others and measured their speed. The result was, he affirms, that when the rays travelled against the hypothetical "ether draught" their speed diminished. When they travelled with the draught their speed was increased.

IT is announced by the Jones and Laughlin Steel Corporation of Pittsburgh that it has developed a new steel product, which is described as being a light type of structural material which can be used in dwellings. A new electrically operated rolling mill has been erected at Woodlawn on the outskirts of Pittsburg to produce the material, which is known as "J & L. Junior." It is stated that the material will resist fire, wind and earthquake, and that while comparatively light in weight, it has greater strength for its weight than any other steel. It is further stated that hitherto it has been impossible to produce this lightweight material for commercial purposes, because there was no process for rolling it, and engineers and steel experts worked for several years before the rolling process was developed.

AN interesting application of modern electric flood lighting is in the Premier Mine, in the Transvaal, where the work of removing diamond-bearing earth is carried on twenty-four hours a day. The mine extends over some 78 acres, and at present has been dug out to a depth of about 500ft. Excavations of diamond-bearing earth in the volcanic vent where diamonds are usually found are done in a series of terraces of 50ft. depth. Since the mine has had to be worked day and night, it was necessary to supply efficient illumination. Arc lighting was tried but the blasting proved detrimental to the delicate mechanism of the arc lamps, resulting in expensive maintenance. Now, electric flood lights housed in fourteen huts are situated on the rim of the mine, with the rays projected from the rim to the working surface at distances ranging from 900ft. to 1600ft.

AT a recent meeting of the Austrian Natural Science Society, of Innsbruck, Herr Martienssen, of Kiel, read a paper in which he described a new electric safety lamp for the use of miners in places where fire-damp explosions are feared. After many unsuccessful attempts, Martienssen claims to have succeeded in producing a fire-damp-indicating electric lamp by using small semi-circular loops, made of a preparation of palladium, placed in a small glass bulb which is closed at its upper end by a porous stone. By means of a button switch, the current from a small accumulator carried in the base of the lamp is passed through the filament, which causes its extremities to assume a dark red colour, this serving as an indication that the apparatus is in proper working order. If there is methane in the air in the mine, the centre of the filament commences to become more or less incandescent, and if the methane percentage reaches 8 per cent. the filament will remain incandescent even when the current from the battery is switched off. In this way Martienssen considers that it is possible to estimate approximately the quantity of methane in the air in mines.

THE conclusions of Mr. J. H. Hruska, after an investigation into the subject, reported in the *Iron Age*, are that in the manufacture of large ingots, exceptionally strict specifications of chemical composition proved to be positively only of a theoretical value, if not useless, on account of the increased effect of segregation on soundness and pouring practice in general. The requirement of a clean steel, *i.e.*, without slag or other non-metallic inclosures or impurities—sonims, refractories, &c.—as well as a quiet molten metal cast at a proper speed and temperature, should be more closely controlled than final analyses—except ladle tests. On the contrary, determinations of chemical analyses of inclusions, or the composition and quantity of occluded and absorbed gases, will be of a greater value and importance for the future improvement of the manufacture of ingots than just a few points of carbon or a little more manganese. This statement does not mean to eliminate chemical analyses; the correct opinion of a steel quality, however, can be obtained only by taking both factors—analysis and melting or pouring practice—into proper consideration.

ALTHOUGH the United States has very many molybdenum deposits, ranging in size from those which produce only a few flakes of molybdenite to those in which there are millions of tons of ore, only two molybdenum mines were operated during 1925, the market not having yet grown sufficiently large to warrant the operation of other mines. The two which operated are well equipped, and are owned by companies which make their own molybdenum compounds to be sold to the steel trade. In Colorado the Climax Molybdenum Company operated throughout the year at Climax, about 15 miles, by rail, north-east of Leadville. In New Mexico, the Molybdenum Corporation of America operated its mine in Sulphur Gulch, about 7 miles east of Questa. Together the companies produced 97,665 tons of ore, from which was made 864 short tons of concentrates carrying 72·7 to 85 per cent. molybdenum sulphide equivalent to 1,154,065 lb. of molybdenum (metal). A few tons of molybdenite are used each year for making chemicals, and a few thousand pounds of molybdenum are used in the electrical industry, but the bulk of the production is used in machine steels.

Miscellanea.

AN electric power transmission line is to be constructed from the power-house at Michipicoten Falls, Ontario, to the Goudreau goldfields, a distance of 40 miles, at a cost of 150,000 dollars.

THE first sod on the site of the new terminal warehouse, Toronto, was turned by T. L. Church, Chairman of the Toronto Harbour Commission on April 6th. The building will cost about 7,000,000 dollars.

THE High Commissioner for Canada in London has received from the Department of Public Works at Ottawa a cablegram intimating that the new Esquimalt dry dock is now sufficiently complete for the reception of ships.

THE production of bauxite in the United States in 1925 was 316,540 long tons, valued at 1,988,250 dollars, a decrease of 9 per cent. in quantity and 7 per cent. in value as compared with the domestic production of 347,570 long tons in 1924.

IT is officially announced that the Government of India, at the request of the Bombay Government, has decided, with the approval of the Secretary of State, to appoint a committee of inquiry in connection with the Back Bay Reclamation Scheme.

THE night aviator flies from Jacksonville to Miami trusting mainly to his compass save for the 70-mile stretch from Palm Beach to Miami, which is lighted. At a recent meeting in Fort Pierce, plans were initiated to the end that the entire 390-mile route shall become a lighted way.

ERECTION of the shipping conveyor galleries at Windmill Point Basin, Quebec, which will have a capacity of 1,000,000 bushels per ten-hour day, and will increase the shipping capacity of elevator B by about 50 per cent., will be completed in May. The Harbour Commissioners estimate that the construction of the galleries will cost about 400,000 dollars.

THE Birmingham Tame and Rea Drainage Board, which is responsible for the disposal of the sewage of Birmingham and a number of adjacent towns, recently decided to install at the Saltley works, at a cost of £12,515, a sludge gas power plant. In 1921 an experimental plant was put down at the Cole Hall sewage works for the generation of power from sludge gas. The gas produced in the fermentation of the sewage sludge is composed of 67 per cent. methane, 30 per cent. carbon dioxide, and 3 per cent. nitrogen.

A RESEARCH investigation of the ionisation phenomena which occur in paper-insulated, high-voltage power cables is being made at the Harvard Engineering School under the auspices of the Impregnated Paper-insulated Cable Research Committee. A paper, read before the American Institute of Electrical Engineers by Messrs. C. L. Dawes and P. L. Hoover, gives some of the preliminary results which have been obtained, certain tentative conclusions that are suggested by the data, and a description of the method developed for making the measurements. It is a preliminary report, and in subsequent papers it is intended to record the progress of the investigation as it proceeds.

THE Association of Floor Constructors has had under consideration regulations which govern the construction of steel and concrete floors, and in particular the use of coal residues in concrete which is in any way in contact with steel. Having regard to the many cases in which this material has been clearly proved to have corroded the steel, often to the extent of entire destruction, the Association has decided to approach the Government, and all County, Borough and District Councils to take steps to prohibit the use of coal residues in structural concrete in contact with steel. In this connection, it is worthy of note that the revised building regulations of other countries prohibit the use of this material for the class of work mentioned.

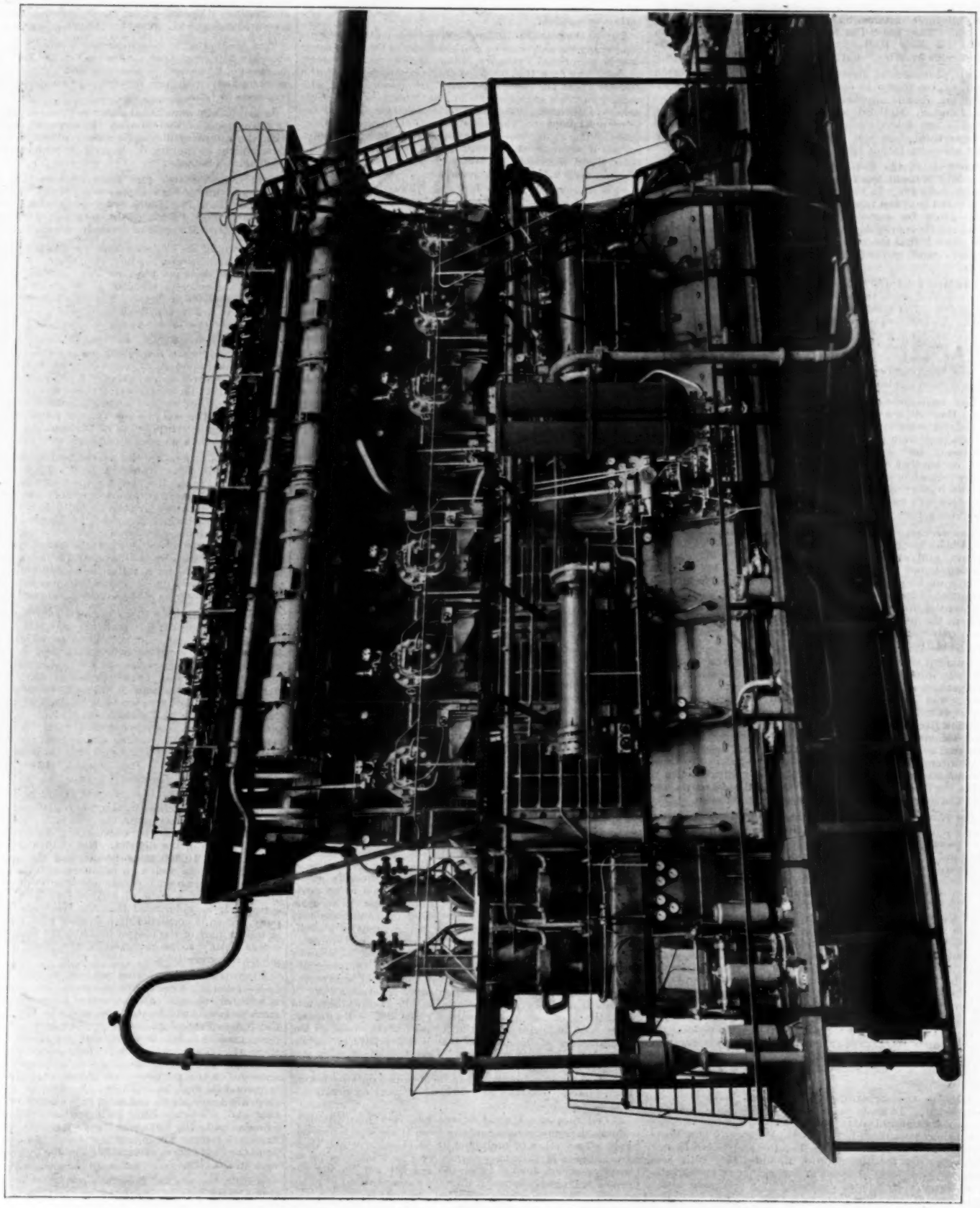
A DECISION on the part of the Canada Northern Power Company to commence work on a transmission line from the big des Quinze plant to Rouyn is, says *Canada*, regarded as one of the outstanding indications of big developments in the district. Not only will the new line assure about 10,000 horse-power, but the power site at des Quinze lends itself to a big increase in power development at any time such construction is required. Clearing and burning of a right of way can be completed before spring. It is understood that the Noranda Mining Company, which is constructing a smelter this year, will meet at least a part of the cost of building the transmission line—this outlay to be returned in the form of a monthly rebate on power bills.

TAXI-CAB telephones that can only be used for incoming calls—from the hirer to the cab rank—are being installed at taxi-cab ranks in various parts of Liverpool, by arrangement between the Post Office and the Liverpool Motor Cab Trade Protection Society. Manchester and Bradford have made similar arrangements for the installation of these telephones, which have been successfully tried in London. The box containing the telephone is just large enough for the purpose; no means of calling exchange is provided, and, in addition, the door is automatically controlled so that an ordinary call cannot be made from that end. When a hirer calls up the cab rank a gong sounds inside the box, and the door opens to permit the driver to reply. The Society, which rents the telephones from the Post Office, intends to have one installed on every rank in the city.

AMONG the annual premiums awarded by the French Office National des Recherches Scientifiques et Industrielles is that known as the Jean Bares Award, which is offered to the inventor who is the father of at least three children and who is regarded as having rendered the greatest service to French industry. For 1925 the premium, which amounts to 10,000f., has been awarded to M. Vedovelli, who not only fulfills the requirements as to parentage, but has risen from the rank of an ordinary engineering fitter. M. Vedovelli has more than 100 patents, and has a wide reputation in connection with high-tension apparatus and control gear. It was M. Vedovelli who was responsible for the electric luminous fountains at the Paris Exhibition of 1900, and twenty-five years later for the electric waterfall and other electrical illuminations at the Paris Decorated Arts Exhibition of 1925.

4000 B.H.P. DOUBLE-ACTING FOUR-STROKE MARINE OIL ENGINE

(For description see page 559)



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SIXTEEN-PAGE SUPPLEMENT—"THE METALLURGIST."

The Metallurgist

THE MAY NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

THE ENGINEER.

MAY 28, 1926.

The Lessons of Jutland.

WE publish on another page a concise narrative of the great naval engagement that took place ten years ago in the North Sea between the British and German main fleets. In this tremendous conflict every weapon employed in sea warfare played its part, for if the airships and the submarines which had been mobilised to cover the sortie of the German battle fleet were not present during the actual fighting, they were so disposed as to be ready for action had the battle been resumed on the following morning. Even the aeroplane was represented by the machine that flew off from the deck of H.M.S. Engadine and brought back to Admiral Beatty a useful report of the enemy's movements. Ten years is a comparatively short period in the history of a nation, but in the development of naval science it may suffice to produce revolutionary changes. How little resemblance, for example, did the British Navy of 1873, with its mastless turret ships and numerous ironclads armed with rifled guns, bear to the Navy of 1863, which had consisted mainly of unarmoured wooden ships equipped with smooth-bore ordnance. Again, what a striking contrast the Fleet of 1904 afforded to that which proceeded to its war base at Scapa ten years later. Within that decade the Navy underwent a complete transformation. The mixed-calibre battleship had given place to the Dreadnought, the battle-cruiser and the high-speed light cruiser had been evolved, the destroyer had grown into a sea-going ship, and the submarine become a potent and reliable instrument of combat. But if we compare the Fleet that fought at Jutland with our present naval establishment we shall find no outstanding differences in respect of material. Capital ships of the type we possessed in 1916 constitute the backbone of our present Fleet. Indeed, excepting only the two "Nelsons" and the Hood, our battle fleet is composed entirely of pre-Jutland ships, just as the whole of our cruisers and destroyers now in commission were built under war-time programmes from designs directly inspired by the lessons of Jutland.

The growth of the capital ship has been arrested by international treaty, while smaller vessels are also affected, required as they are to conform to rigid limits of displacement and armament. But for this artificial impediment to progress all types of fighting craft, from the capital ship downward, might by now have developed out of recognition. It is important that the absence of any notable advance in naval material during recent years should be borne in mind, since weapons necessarily govern tactics. Consequently, were a fleet action to take place to-morrow under geographical and other conditions resembling those at Jutland, it must and would be fought out on very much the same general principles. Aircraft would, no doubt, be greatly in evidence, though there is no certainty that their operations would produce decisive results. It is extremely doubtful whether popular forecasts of aircraft compassing the destruction of battleships by bomb attack would be fulfilled, for the only aeroplanes able to participate in an action fought on the high seas would be those operating from carriers, and such machines cannot transport bombs of sufficient calibre to inflict serious injury on a Dreadnought. The torpedo-plane, also, is an experimental arm, of which the efficacy under war conditions has yet to be tested. It suffers from the grave disadvantage of having to fly almost at sea level when delivering its attack, thus becoming a fair target for flat-trajectory fire. It is, we think, more as a medium for reconnaissance and communication than as an independent weapon of offence—save perchance against submarines—that the aeroplane will justify itself in naval warfare. Again, there is not the slightest reason to assume that submarines would materially influence the course and outcome of a deep-sea fleet action in existing circumstances. Neither in speed, manœuvring qualities, nor armament does the submarine show any appreciable improvement. On the other hand, the battleship, thanks to its bulge protection and improved subdivision, has become less sensitive to the blows of the torpedo. We therefore assert with some confidence that if Jutland were re-fought to-morrow the gun would again prove the decisive weapon, and that the capital ship, as a mobile carriage for the heaviest and hardest-hitting guns, would vindicate its reputation as the basic element of naval power. That the Admiralty War Staff shares this view is made clear by the present organisation of the Fleet, which differs in no essential particular from that of 1916.

The literature of Jutland has now grown to imposing dimensions. Every phase of the battle has been recorded and debated by historians on either side, and even among the minor incidents there are few which remain obscure. The only important points on which enlightenment has not yet been vouchsafed are, first, the disconcerting vulnerability of our battle cruisers; and, secondly, the unsatisfactory effects of our gunfire. As to the first point, we have searched in vain through the official narratives of the battle for a clue to the mystery. Official circles appear to have adopted the theory that the Queen Mary, the Indefatigable, and the Invincible were all destroyed by "lucky hits," and small encouragement is given to those who seek a more scientific explanation of the phenomenon. But there is no gainsaying the fact that the ships were lost in consequence of some fundamental error in their design. Precisely where the weakness lay, whether in the inadequate strength or faulty distribution of their armour, in the plan of their barbettes and magazines, or in the method of ammunition stowage, can only be determined by those who have access to the complete designs. These ships were notoriously built to satisfy the exacting demands of certain officers whose tactical theories were largely disproved in practice. Long-range action was the keynote of our earlier battle-cruiser designs, which provided a sufficient margin of speed for choosing the fighting distance, guns superior in range and weight to those of the probable adversary, and just enough armour to resist projectiles fired at extreme range. It does not appear that the climatic conditions normally prevailing in the latitudes where these ships were destined to fight were given a moment's thought. A further consideration overlooked was the natural and laudable desire of our fleet commanders to come to grips with the enemy whenever he showed himself at sea. At such a time the fine points of a new tactical doctrine are apt to go by the board. Thus, when Admiral Beatty sighted the German scouting squadron at Jutland he proceeded to close at full speed, and did not open fire until within 16,000 yards. Very soon the range had dropped to 13,000 yards, at which distance the smaller German guns were extremely effective against our thinly-plated ships, while their own heavily-armoured vessels were able to resist our

projectiles, deficient as most of them were in penetrative power. Had Admiral Beatty fought by the book he would have come into action at 18,000 yards or more, using his superior speed to maintain the range at this figure, and declining to be drawn within reach of the enemy's lighter guns. Had he pursued that course, however, the duel must have resolved itself into an indecisive game of long bowls, and it is highly improbable that the main fleets would ever have come into contact. To inflict fatal damage on the German battle-cruisers at a range of ten miles would have demanded a higher standard of gunnery than was attainable with the methods in vogue at the date of Jutland.

It is, therefore, hardly to be doubted that the tactical doctrines governing the design of our battle-cruisers were unsound. Jutland exposed the fallacy of building ships to meet purely hypothetical conditions. That is the first lesson of the battle so far as ship design is concerned. There are features of the "Nelson" class, such as the concentration of the main armament in the fore-part of the ship and the resulting sacrifice of stern fire, which raise a suspicion that this lesson has not been taken closely to heart. We fear, too, that the design of the 10,000-ton cruisers now building in this country and abroad does violence to the same teaching. In effect these vessels are miniature battle-cruisers, in which all the worst defects of the prototype reappear in exaggerated form. In order to achieve the highest possible speed, combined with a disproportionately powerful armament, their protection has been cut down to vanishing point. They must either engage at very long range or else incur the risk of summary destruction. It is true that special circumstances appear to have produced this dubious type of vessel, and that all the units of the class, foreign no less than British, share in common its patent defects. Nevertheless, we question the wisdom of building fighting ships which may prove too vulnerable to fight, and a lively controversy is to be anticipated when, if ever, the plans of our new "County" cruisers are released for publication.

As for the disappointing results of British gunnery at Jutland, these must be ascribed to two main causes, poor visibility and an inadequate quota of armour-piercing shell. The great majority of our projectiles discharged in the action were of the high-explosive variety, which failed to make much impression on the stiffly-armoured German ships. The value of H.E. attack on such targets had clearly been overrated by our gunnery experts. But whenever our A.P. shell went home they appear to have acted admirably. Readers may recall the series of striking photographs, published in THE ENGINEER of February 20th, 1920, which revealed the devastating effect of these shells on the German ships at Jutland. Visual evidence was afforded of the ease with which they had passed clean through turret and side armour up to a thickness of 12in., to explode inside with pulverising force. The Seydlitz had no less than four of her five turrets knocked out, while the Derfflinger and the Lützow lost two apiece. Had our ships' magazines contained a larger proportion of A.P. projectiles it is virtually certain that many more German vessels would have been sent to the bottom. The experience of Jutland taught us that well-armoured ships have little to fear from high-explosive shell, and should therefore be attacked with armour-piercing projectiles carrying the heaviest possible burster. There is good reason to believe that this lesson, at least, has been thoroughly digested by our naval authorities.

Coal and Economics.

IT is difficult in the affairs of this world to maintain an attitude of detachment. Even amongst philosophers, and, worse still, amongst scientists, personal bias intervenes and diverts judgment more or less to the right or left. A broad education might be expected to correct this tendency, but since it is found amongst the best educated men, such as biographers and historians, we must face the fact that it is one of those inherent qualities of the human race which we are no more able to remove than the natural tendency of oxygen to combine with carbon. The Great Analyst looking at men, as men look at substances in their laboratories, probably finds them, in the lump, just as constant to certain laws as everything else in the world. At no time in the world's history has this fact been so fully recognised as in the present, and, as a consequence, we find as a rule a toleration of diverse views which would have astounded our forebears. Even the display of a totally different spirit which we have seen but lately does not vitiate our argument, for the Great Strike was carried on with remarkable toleration—amounting almost to good humour, as if it were but a game—on both sides, and finished with the calmness of an ended comedy. Small wonder that more fiery-natured nations were dumbfounded by the phlegm of Great Britain.

It is to this spirit of toleration that we must look for the settlement of our industrial difficulties, but with it we must endeavour to combine the detachment to which we have referred in our opening sentences. For, fundamentally, many of the problems with which we are faced are not human problems at all, but purely economic problems. Class consciousness has no place in them. The feelings of the employers towards the employed, or of the employed towards the employer, do not affect them one whit. We suppose that nearly all employers would rejoice to see their workpeople better off, and that relatively few of the employees are really jealous of the fine houses, the fine clothes and the motor cars from which their employers are presumed to derive more enjoyment than they deserve. The men and women on both sides are much the same; good-natured people who like to see happiness and contentment around them. It is only warped intellects that preach class hatred and look upon the opposite party as composed, whichever it may be, of villains or parasites. If we glance back through the industrial history of Great Britain, we shall find that nearly all the great reforms, the Factory Acts, for example, and, of course, the reform of collieries, came from the capitalists, just as we find to-day the beneficent but ill-named Welfare Movement encouraged and supported by the employers, even when the employees show a lack of interest in it. On the other side, we have but to enjoy the acquaintance of workpeople to know that there is nothing approaching that lack of sympathy which thunders from labour platforms. Taken in detail, works by works, it will be found that a large majority of our factories are carried on with a kindly enough mutual understanding between the workpeople and the owners. Why is it, then, that we cannot get away from continual strife? We believe the answer is to be found in the lack of power of detachment, the ability to look at economic questions without personal bias. We know, from their public utterances, that many labour leaders encourage that bias, they play upon it to effect their own ends, and they know that in the poorly educated masses to whom they speak it is easy to provoke. They deliberately destroy that detached consideration of an economical problem which is essential to progress, and frequently oblige the country to do what it is necessary to do by force of law, when reason fails. The coal question which is exercising every thinking mind to-day is essentially economic. It would be absurd to pretend that the Royal Commission desired to "grind the faces" of the poor collier; the report is, in fact, more sympathetic to the collier than to the mineowner. In recommending a temporary reduction of wages, the Commissioners were moved only by the economic necessity of that step. It is manifest that the coal industry is at the present time being carried on uneconomically, since it has cost the country something like twenty million pounds to keep it going. It is that sheer, hard, economic fact which the coal worker is up against. His leaders have not shown how it can be circumvented, they have not shown how more coal can be won for less money. They failed even to substantiate their charges of mismanagement and bad organisation. They insist upon the retention of conditions which would entail a State expenditure of well nigh half a million pounds per week. That way lies disaster. No industry can be carried on on those lines. But if the coal industry ceases in this country everything else ceases, and the miners themselves will be the first to suffer from the refusal to obey a law which it is outside the power of man to control. If they could only see that economic laws are just as impregnable as physical laws, that they can only be turned to use when they are obeyed, then they would appreciate that what they are doing by their opposition will deprive them of the very thing they seek—better conditions of life.

We hear that America is enjoying a period of prosperity unexampled in the world. Nearly everyone has already some luxuries, and the way to more and ever more opens before them. The progress of this astonishing success has been thus described to us by an eminent American observer. A large demand cheapened production and increased wages; the high wages augmented purchasing power and enhanced the demand. The greater demand still further diminished the cost of production, and led to still higher wages and still more employment. The market grew again with widened purchasing power, and so on. Prosperity is moving in an ever and ever widening circle, and an ever and ever greater rate. We cannot expect in this country, which is unable to support itself, ever to duplicate the conditions that prevail in America. There industry is a pump which continuously circulates money through a closed conduit. Here we must have foreign trade, and our pumps must deliver, in part, to a network of mains laid all over the world. But, whilst the conditions are essentially different, the basic principles are essentially the same. Cheaper production, as industry invariably shows, means greater production, higher wages, more purchasing power and greater prosperity all round. No one denies, the Royal Commission least of all, that the coal industry in this country stands in need of reform. That reform will be carried out if the industry can be carried on, and after a temporary reduction of wages the money that may be earned by miners will be increased in itself, and its purchasing power will be augmented by the reduction in the cost of other commodities. That is the lesson of economics, the lesson which America is giving us at the present time. But to learn it we must seek detachment from personal bias and not be mad enough to deny prosperity to others when our own prosperity depends upon it.

Wages Boards for the Coal Industry.

THE attitude taken by the coalowners towards the proposed wages boards for the coal industry, and particularly in respect of the independent chairman, is very like that adopted by the railway companies in 1907. The history of the successive steps which led up to the establishment of the railway scheme which Mr. Baldwin adopted as a precedent for his coal mining settlement proposals is instructive. For fifteen months or more prior to November, 1907, there had been considerable unrest in the railway world, and the Amalgamated Society of Railway Servants had prepared a National Programme, which the companies were asked to receive through the general secretary, Mr. Richard Bell. Each company sent substantially the same reply; it was willing at all times to receive deputations on such subjects, but only from representatives of its own men. At that time Mr. Lloyd George was the President of the Board of Trade, and he suggested the formation of conciliation boards, which were to be composed of an equal number of officers and men. In the event of the board being unable to agree on any question, the point was to be referred to an arbitrator appointed by the Speaker. The companies strongly objected to such important matters being left to the decision of an irresponsible outside person, but as recognition was also wanted by the men and by Mr. Lloyd George, it was considered that the single arbitrator was the lesser evil, and the proposal was therefore accepted. The result was very satisfactory to the companies, but bad for the men. The latter were ill-advised, and submitted the whole of their National Programme as their demand. No agreement at the conciliation boards was, of course, forthcoming, and the demand went to arbitration. Among the men chosen to adjudicate were Sir Edward Fry, Sir Henry Duke, and Lord Gorell—the last-named travelled on the footplate of a Great Eastern express to get first-hand evidence on a point—and the net result of the men's claims was infinitesimal. What made the situation worse for the men was that one of the rules stated that a subject on which an award had been given could not be reconsidered for a period of time named in the award. Hence, as the National Programme covered practically every possible field, there remained no grievance to submit. It was the discontent that developed from that feature which, mainly, led to the railway strike of August, 1911, out of which a new conciliation scheme was established in November, 1911. In it arbitration was abolished, but recognition accepted. It was in every way a success, and would, but for the war, no doubt have been in operation to-day. It was set up, however, for only three years, and whilst—because of the conditions prevailing—it was continued by agreement for another year or so, the control of the railways by the Government rendered any board unnecessary. The next stage opened on December 6th, 1918, when the then President of the Board of Trade announced that an eight-hour day for railwaymen was to come into

force on February 1st, 1919, and that a new committee, to deal with pay and conditions of service, was forthwith to be set up. No such committee was, however, appointed, probably because it was the intention of the Government, as announced by Sir Eric Geddes on the second reading of the Bill that became the Ministry of Transport Act, 1919, to take labour into the confidence of the Ministry. The failure to redeem that promise was no doubt the real reason of the general railway strike of September–October, 1919, as the manifesto of Mr. J. H. Thomas appeared on the same day, September 23rd, on which the Ministry officially came into being. Then on December 8th it was announced that central and national wages boards, on which the users of railways were to be represented and over which an independent chairman was to preside, were to be established. That was done soon afterwards, and by the Railways Act, 1921, those boards were permanently established. For over six years now they have done admirable work, and Mr. Baldwin's proposals that the mining industry shall have similar boards would, if we may judge by the experience of railway companies and railway servants, appear to be one worthy of favourable consideration by the coal industry.

The Paris Industrial Fair.

(By our Paris Correspondent.)

WHEN the first Fair was held in Paris, before the war, the intention was that it should be a manifestation of national industry which would attract buyers from all parts of the Continent. The general arrangetion and the classification have remained unchanged, but the character of the Fair has been modified from year to year. At first most of the great engineering firms participated largely in a show that promised to give good commercial results. Then the leading manufacturers found that they could not do justice to themselves in exhibitions of a universal character, and covering a necessarily restricted area. It was also observed that the class of people who visited the Fair displayed little interest in big engineering productions, and, as a consequence, the machinery section, although large, became only representative of particular sections of the mechanical engineering industry. Then the Fair underwent another change when it was made international, and foreign manufacturers profited from the facilities offered to introduce their productions on the French market. It is quite possible that the foreign element will become more important in the future, for the annual Fair, which is now held in the vast exhibition grounds at the Porte de Versailles, certainly offers a means of reaching a large class of customers, although the space allotted to each section of industry is so small that the results are certainly less satisfactory than they would be if a separate exhibition were devoted to engineering products. As a means of presenting such manufactures as machine tools and machinery of all kinds employed in different industries, the Paris Fair would doubtless be entirely successful if one of the large halls were set apart solely for the mechanical engineering trades instead of these being, as at present, crowded amongst wireless, electrical and other accessories which take up more than one-half of the space. Except for the Lyons Fair, no other periodical exhibition of machinery is held in France, and with a suitable organisation the Fair in Paris should render considerable service to the engineering trades.

In the machinery section, apart from petrol and oil engines and general engineering products, most prominence at the recent Fair was given to machine tools, and the foreign element was large. In view of the difficulty of selling British and American productions when a depreciated currency inflates prices to a prohibitive level, the extent of the American participation would appear surprising, but it was justified by the considerable changes which have taken place in certain industries, particularly in the construction of motor cars, in which makers have found it necessary to replace as much as possible a less efficient labour by the best and most economical machinery that can be procured. Users can afford to pay high prices for special machines which will enable them to turn out accurate work more rapidly with a relatively lower wages bill, and one of the features of the mechanical section was the number of American high-duty lathes, grinding machines and other special productions. All these were exhibited by French agents, and it may be remarked that foreign firms can hope to do little in exhibitions of this kind unless they are represented by agents who are responsible to French buyers for deliveries and the supply of spare parts. For the first time, German makers exhibited gear-hobbing and other machines, and in view of the position they have secured in the French market with the supply of machinery on account of reparations, it may be assumed that they will take an increasingly active part in future exhibitions. The British participation was disappointingly small. It is true that the Federation of British Industries had an office for supplying information, but there were very few British exhibits. Heavy oil engines were shown by Crossley Brothers, Ltd., and by Tangyes, Ltd., and automatic weighing machines were exhibited by W. and T. Avery, Ltd., and by S. Denison and Son, Ltd. These latter machines are among the rare British productions which are finding a large sale in France, for they are being used in nearly all the big shops in Paris, and, for the moment, the British automatic weighing machine stands alone. On the other hand, there are, curiously enough, some classes of British manufactures which are presented under French names, and it is only by unobtrusive marks that their origin can be discovered. This was the case, at the Fair, with a machine for folding and stacking catalogues. There are other kinds of machines which are notoriously imported from England and sold under French names. There is business to be done in British mechanical goods, even in a monetary situation which would appear to raise prices to a hopelessly high level, but it can only be done in machines fulfilling special requirements and enabling users to realise economies that cannot be secured by other means.

The French exhibits in the machinery section comprised mainly the ordinary class of machine tools, such as engine lathes, boring machines, radials, milling machines, and, generally, all the requirements of the average engineering shop, and the quality was usually of a satisfactory standard. The French machine tool industry has, however, for a long while lain under a more or less acute depression, partly because the general class of users are not in a position to renew old plants, and partly for the reason that, until recently, the market was burdened by considerable quantities of German machine tools supplied on account of reparations. Nevertheless, the French machine tool industry has made considerable progress, and is capable of supplying most of the ordinary requirements, but it must be admitted that the French user invariably attaches more importance to foreign machines bearing the names of reputed firms. When prices adjust themselves, British makers will not have entirely lost the French market. After the Armistice the Schneider group constituted the S.O.M.U.A. combination of three leading Paris firms, including the Bouhey machine tool works, and this department was developed in the direction of manufacturing all kinds of heavy machines, several of which were exhibited at the Fair. As was the case elsewhere, the production outstripped a demand which rapidly fell off during the financial crisis, and S.O.M.U.A. has now embarked upon the manufacture of printing machinery, which, apart from such old firms as Marinoni, is practically a new industry in France, so far as machines of large capacity are concerned. Heavy boring and turning mills were shown by Sculfort, Fockeday, Vautier et Cie., of Maubeuge, who maintain the traditions of the Maubeuge industry, which at one time stood alone in the production of the bigger kinds of machines. The universal milling machines of the Etablissements P. Huré have a high reputation in France, and Messrs. Cuttat et Cie. are particularly successful with their automatic lathes. The French exhibits of lathes, shapers, radials and other machines was large, and while they were generally of good quality, and some highly creditable, there was little that suggested an effort to adapt machine tools to more economical production. More prominence was given this year to paper-trimming and paper-folding machines, and in this class again German makers were represented, as well as in machines for nailing packing cases. The Germans only present machines that aim at saving time and labour. These are the only productions in which foreign makers can hope to do business in France under present conditions.

In the Fair grounds it was obviously difficult to organise engineering exhibits, when, despite the large area available, the bulk of the space was occupied by streets of small wooden huts devoted to every conceivable branch of French industry. An exceptionally big area was allotted to agricultural machinery, which, in previous years, was thoroughly representative of French agricultural engineering and was perfectly organised by the French Makers' Association, but when the Fair became international the Association withdrew its participation, and the agricultural machinery section lost all its former interest. It is characteristic that the only harvesting machines shown were of German manufacture. One feature of interest in this section was the predominance of the heavy oil engine for agricultural purposes and the successful application of suction gas plant using charcoal as fuel for lorries and for the driving of farm machinery. A more general employment of the suction gas engine has been delayed by the cost of charcoal, which increased considerably with the prospect of a heavy demand, and there can be no future for this fuel unless means be found of producing it in sufficient quantities to meet all demands. The only way to attain this end is to encourage the manufacture of suitable portable plants for carbonising small wood, and several forms of such apparatus are already on the market giving more or less satisfactory results. One such plant was shown by M. C. Dehommeau, of Clère (Indre and Loire). The other exhibits in the grounds comprised mainly machinery associated with the economical construction of buildings. Elevating machinery, concrete-mixing machinery, presses for making building material out of conglomerate, slag, and crushed stone, were shown in large numbers. Nearly all of it was of French manufacture, and foreign firms which introduced anything really satisfactory for cheapening building construction would doubtless find a good market in France. A large area was covered by economical buildings, but only one was constructed of steel.

The Paris Fair is of far too general a character, and offers too little space, for the satisfactory presentation of engineering products, but it provides an opportunity to foreign makers to introduce anything that will meet French requirements, and to this extent the show appears likely to gain in importance every year. It attracts a considerable number of foreign visitors who are interested mainly in the purchase of essentially French goods, and the situation of exhibitors this year was particularly embarrassing when such buyers offered to place large orders while the fall of the franc seemed to be accelerating beyond all hope of early recovery, and French makers find it less hazardous to keep their goods than to replace them at a cost that it is impossible to estimate.

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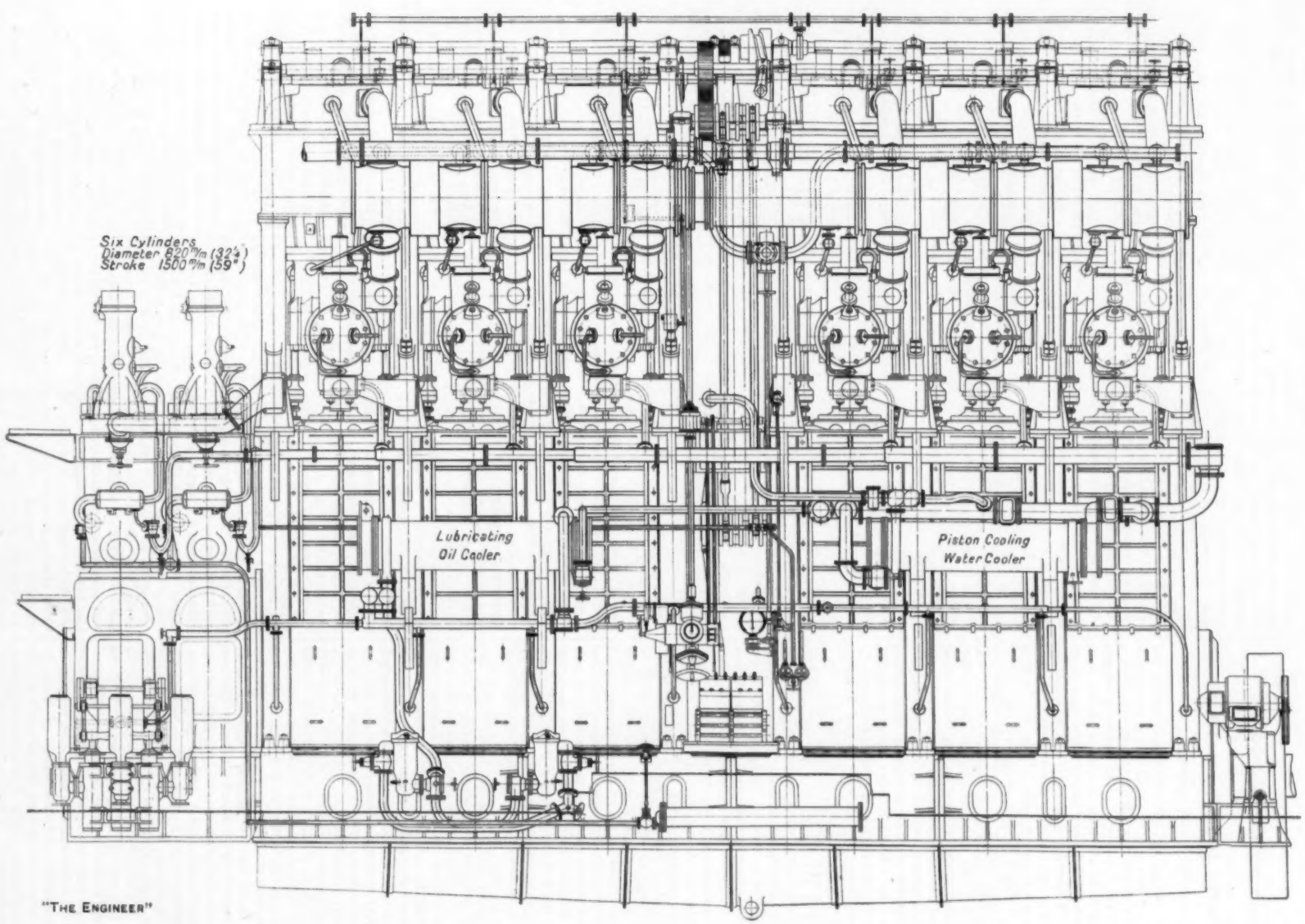
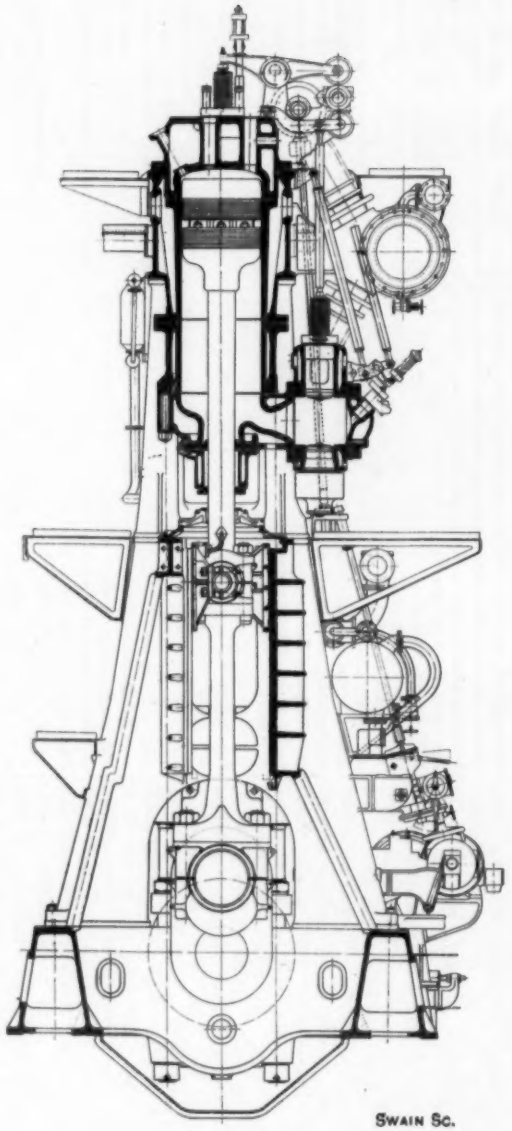
4000 B.H.P. DOUBLE-ACTING FOUR-STROKE MARINE OIL ENGINE

NORTH-EASTERN MARINE ENGINEERING COMPANY, LTD., WALLSEND-ON-TYNE, ENGINEERS

(*For description see opposite page*)



"THE ENGINEER"



SWAIN SC.

Double-acting Four-stroke Marine Oil Engine.

SUCCESSFUL demonstration trials of the new 4000 brake horse-power double-acting oil engine which is shortly to be installed in the motor vessel Stentor, belonging to Alfred Holt and Co., took place at Wallsend-on-Tyne last week. Both on Wednesday, May 19th, and on the following morning a large number of engineers, shipbuilders, and representatives of shipping interests availed themselves of the invitation of the North-Eastern Marine Engineering Company, Ltd., to see the set running on the test bed.

The engine is the first of its type to go into service and it will propel one of the most powerful single-screw ships afloat. A photograph of it is reproduced on page 554, and on the opposite page an elevation drawing of it with a vertical section through one of the main cylinders is given. The principal dimensions are as follows:—Number of cylinders, six; diameter of cylinders, 800 mm. (32¼in.); piston stroke, 1500 mm. (59in.); designed service output, 4000 brake horse-power; service speed, 95 revolutions per minute; diameter of crank shaft, 21in.; diameter of piston-rod, 11in.; indicated horse-power at 92 revolutions per minute, 5000. The design is the outcome of over four years of experimental work which has been carried out chiefly at Wallsend in collaboration with the Werkspoor Company, of Amsterdam, under whose licence the engine is built. It is hardly necessary to do more than refer to the large experimental unit, which was a single-cylinder engine with a bore of 800 mm. (31½in.) and a stroke of 1400 mm. (55in.), designed for an output of 600 brake horse-power when running at a normal speed of 95 revolutions per minute. An account of this engine will be found in the issues of THE ENGINEER for May 30th and June 6th, 1924, while in our issue of June 13th, 1924, some of the test results were given. The engine has been running on and off during the past two years and the experimental work has included four continuous runs of from twenty-one to eighty days' duration, the engine having made over 30 million revolutions during these trials. Experiments made with three grades of fuel oil showed conclusively that a fuel consumption of slightly over 0·42 lb. per brake horse-power could be obtained. With the new six-cylinder unit it is quite possible that even better figures may be secured.

THE NEW DESIGN.

A detailed account of the design of the experimental engine will be found in the articles above mentioned and in a paper on "A New Type of Double-acting Diesel Engine for Marine Purposes," which was read by Mr. G. J. Lugt and Mr. Harry Hunter before the joint summer meeting of the Institution of Naval Architects held in June, 1924. A summary of this paper was printed in THE ENGINEER of July 4th in that year. For changing from a single to a multi-cylinder unit such as we illustrate little alteration in the main principles of the design has been made. The bed-plate, the columns, and the reciprocating parts, which are clearly shown in the accompanying drawing, follow closely accepted marine oil engine practice. It will be seen that the running gear is fitted for forced lubrication.

A built-up crank shaft of the firm's patented Unity type is employed and the top caps of the main bearing are held in position by nuts on the through-going stay-bolts. Each crosshead is guided by one ahead and two astern guides, sufficient space being provided between the guides to allow the top end of the connecting-rod to be swung outward for dismantling.

Standard cast iron A columns, which are braced together by intermediate transverse entablatures, are used for the main structure and are designed on lines which follow closely the practice employed in the experimental engine and which, we learn, has also proved most successful in the single-acting North-Eastern engine which was installed in the motor ship Raby Castle.

Some reference may be made to the piston and its fittings. The piston-rods, which are 11in. in diameter, are made of a special alloy steel. The forging is bored up the centre with a 2½in. hole, which provides a passage for the piston cooling water. At the head of the piston-rod is a large flange, to which the piston body is attached, this being the only joint. For attaching the pistons to the connecting-rods bolts of nickel-chrome steel are used, and special precautions are taken to guard against any fracture. The joint between the piston and its rod is a ground one and it is subjected to a water test of 1000 lb. per square inch. Each piston has eleven rings, divided into two groups. A recess in the middle of the piston serves to take the heads of the piston bolts, and incidentally it also provides a ready means of gauging the tightness of the piston rings whilst the engine is working by the variation in pressure in this recess. If leakage occurs it generally takes place past the top series of rings, and in such a case the pressure on the piston body recess will be increased. An automatic valve operated from the cam shaft puts this recess into connection with a gauge every time the piston recess passes an opening arranged at the side of the liner. Thus any rise in pressure can immediately be detected by the attendant.

It will be seen that the piston water cooler is mounted on the engine columns. Fresh water is used, and inside the piston special arrangements are provided to ensure a positive and quick circulation of it. The cooling water is conveyed to the piston by telescopic pipes of heavy gauge. We noted that a combination type of packing fitted in a stuffing-box which gave some degree of flexibility was used with apparently very satisfactory results. Equal flexibility was also noted on the large stuffing-boxes of the main piston-rods. Special Perlit iron packing rings are employed. This same high-grade cast iron is used for the pistons, stuffing-boxes, top cylinder head, bottom cover, combustion chamber, valve bodies, and indeed most important engine parts other than the main frames.

The usual North-Eastern arrangement for giving access to the pistons by dropping the bottom cylinder casing has been retained, and this arrangement makes the task of inspecting the internal surfaces of the cylinders and gauging their diameters a relatively easy one. The cylinder liner is made in two sections with an expansion joint between them. When the engine is warmed up and in running condition the joint is closed, but it is slightly open when cold. The solid type of top cylinder head is retained with the fuel valve offset from the centre, so that ample water space between the various valve pockets is obtained. It will be seen that the top liner is separated from the cylinder head and that the joint is made just above the point of travel of the top piston ring. Such an arrangement enables a new liner to be fitted to an old cylinder head if required. For this joint stainless steel studs and nuts are used.

With regard to the bottom cylinder cover, it may be remarked that the stuffing-box is bolted to the cover, the examination of the piston-rod packing thereby being facilitated.

An essential feature of the engine is the separate bottom combustion chamber which is attached to the side of the bottom cylinder cover. It is furnished with a ground face and carries the exhaust, inlet, fuel, and relief valve. The valves for the bottom and the top cylinders are interchangeable and may be easily and quickly removed when necessary. In the case of the bottom fuel valve a special compensating gear is fitted to the actuating motion so that the downward expansion of the main cylinder when heated is fully provided for.

It may here be stated that for reasons of reliability and accessibility the offset type of lower combustion chamber is made use of, which means that the bottom side of the cylinder works at a lower power than does the top side. Maximum compression pressures of about 550 lb. per square inch on the top side of the piston and 400 lb. on the bottom side of the piston are of the order used.

THE STARTING AND REVERSING GEAR.

The upper valve gear is of the standard North-Eastern Werkspoor pattern. The excentrics on the reversing shaft lift the valve levers clear of the cams, and reversal is accomplished by a sliding cam shaft with ahead and astern cams. Assuming that the engine is to be manœuvred from ahead to astern, the starting shaft is first put into the stop position in which its excentrics lift the bottom fuel valve levers clear of the cams. The reversing shaft is then rotated and the scroll cam at the centre during its first 120 deg. of motion lifts the top valve levers clear of the ahead cams. During the next 120 deg. the cam shaft is moved transversely and the astern cams brought into position, while the last 120 deg. of the scroll cam motion drop the valve levers on to the top astern cams. The starting shaft is then moved to the position in which all the cylinders are on starting air and the bottom levers are again brought into action and the engine run up to speed.

Movement of the reversing shaft is obtained by a rack and pinion arrangement which is operated by an air cylinder in conjunction with an oil dashpot. The starting shaft is turned by a compressed air motor. The following five working positions are automatically indicated on a dial placed at the central control station at bottom platform level:—

(1) Stop. (2) All top cylinders on air. (3) Three top cylinders on air and three top cylinders on fuel. (4) Six top cylinders on fuel. (5) All cylinders double acting.

The valve gear is such that in all positions of the gear except the last the bottom exhaust valves are held open and the bottom inlet valves shut and out of operation. By this means the hot exhaust gases from the top cylinders are utilised to warm up the bottom combustion spaces. Besides actuating the valve gear, as already described, the starting shaft controls the main starting valves in the usual way and also controls the fuel pumps and the fuel injection air.

The engine is fitted with a separate fuel pump for each cylinder, which is double acting, one end supplying the top cylinder and the other end the bottom cylinder fuel valve. Fuel delivery is regulated by controlling the lift of the suction valve in the standard way. An Aspinall governor is also fitted, which works directly on the suction valves of the fuel pump and by holding them open cuts off fuel from the engine. The fuel pumps are situated at the centre of the engine below the control gear.

During the time of our visit the engine was running very smoothly on about three-quarter load, which was applied by the usual Froude type water brake. Starting was demonstrated and the engine picked up very quickly. The air compressors, which are arranged at the forward end, were quiet in operation and the whole engine was very steady in its running. After the demonstration trial it is intended to run a non-stop trial for about ten days, after which the engine will be dismantled for re-erection on the ship.

Going through the shops at the present time are four similar engines fitted with rotary valve gear similar to that described in our issue of February 12th, 1926.

THE MOTOR VESSEL STENTOR.

In conclusion, brief reference may be made to the ship on which the engine described and illustrated is about to be erected. The Stentor was built by the Caledon Shipbuilding Company, Ltd., Dundee, to the order of Alfred Holt and Co., of Liverpool. She has recently been completed and is now awaiting her engines at the fitting-out basin at Wallsend. We inspected her on Wednesday, May 19th, and found her practically completed in every respect save her propelling machinery. The engine-room hatches have been left with temporary fastenings, so that the hatches can be removed to allow the engine parts to be lowered. The main bed-plate will be secured to the broad tops of a built-up engine seating. Electric auxiliaries, both for engine-room and deck use, are to be employed and current will be furnished by four Allen-B. and W. generator sets. The Stentor is one of Messrs. Holt's larger type of standard ships, and she has an overall length of about 430ft. with a beam of 54ft. and a depth of 32ft. Her deadweight carrying capacity will be approximately 10,000 tons. The trials of the vessel will take place probably in about two months' time. They will be awaited with interest on account of the new type of oil engine we have described.

Single Crystals of Metals.*

THE problem of preparing a piece of metal in the form of a single crystal may be approached in one of two ways. As ordinarily prepared, metals and alloys consist of a large number of small crystals, whose size varies in the great majority of cases from about 100,000 to several million in a cubic inch. These result from the fact that when the metal or alloy freezes crystallisation takes place at a large number of centres and the crystals grow until they meet one another. The boundaries, therefore, are produced by the meeting of these crystals and vary very much in shape. It has been known for some time that the crystal boundary is stronger than the metal crystal, in the sense that normally when a metal is fractured it breaks through the crystal and not along the boundary, and the fracture of a metal test piece is the summation of a large number of fractures running through small crystals. Hitherto it has been impossible, except in a very few isolated cases, to determine the properties of a metal crystal apart from those of the crystal boundary. The great and indeed fundamental interest of the problem of preparing a piece of metal in the form of a single crystal, therefore, is that its solution would enable the properties of the metal crystal to be determined.

Evidence has been in existence for some time that, provided that the right conditions obtain, very large crystals can be grown from the liquid. So far as I have been able to discover, the problem of preparing a single crystal direct from the liquid was first solved by Czochralski in 1918, whilst Sauveur was, I think, the first investigator to show that, by carefully straining and subsequently heating metals, crystals of a much larger size than the normal could be produced, and stated that there was a critical stress which produced the largest crystals. Subsequently Ruder, Chappell, Jeffries, and Hanson showed that if a metal is locally deformed and then heated exceptionally large crystals form at some distance from the point at which stress is the severest. If a tapered test piece was used a "strain gradient" was obtained, and it was found that the largest crystals always formed within the strained region, but further from the area of greatest strain the higher the temperature.

The experiments on the production of single aluminium crystals, of which I am privileged to give an account this evening, were begun several years ago by Miss C. F. Elam, my research assistant, and myself. For many months we studied the structural changes produced in a crystal aggregate by deformation followed by heat, which may be summarised as follows:—The first effects of strain are revealed by the presence of slip-bands, and in some cases of twin crystals. The former are completely, and the latter to some extent, removed by heating. No change is observed in the shape of the crystals. Somewhat greater deformation, however, followed by heat, produced actual crystal growth, and at this stage the boundaries of the crystals became active. This activity is shown in the capacity of the growing crystal to push forward its boundaries in certain directions, thus invading other crystals, upon which it imposes its orientation. A still greater deformation produces

* Sixteenth May lecture to the Institute of Metals, delivered May 19th, 1926, by Professor H. C. H. Carpenter, F.R.S. (Past-President). Abridged.

a change which appears to take place exclusively in the boundaries of the deformed crystals. It is here that new crystals are born, possessing a different orientation and a much smaller size. Accordingly, in this third stage there is a refining of the crystal structure. From the point of view, therefore, of producing large crystals from an aggregate of small ones, the intermediate degree of strain is the important one.

The increase in crystal size could be clearly followed in our experiments with an alloy of tin containing a little antimony, where the actual movement of the crystal boundary can be observed and photographed. Our experiments further showed that in the absence of a change of phase neither crystal growth nor recrystallisation will take place in a metal unless it has been plastically deformed and subsequently heated to a certain minimum temperature for a certain minimum time. They also showed that there is no gradual increase in size from the original crystals up to the largest, but that the latter appear to form directly from them. It is clear, therefore, that in the production of large metal crystals the adjustment between mechanical strain and the temperature of heating is extremely important.

Production of Single Crystals in Sheets.

By this time we were ready to approach the problem itself, and our first experiments aimed at converting the crystals in the parallel portion of a test piece 4·0in. by 1·0in. by 0·125in. of aluminium into a single crystal. Calculation showed that the total number of crystals contained in the parallel portion of the test piece was about 1,687,000. After many months of work success was achieved in the following way :—

The test pieces must, in the first place, be accurately machined along the parallel portion. In order to convert this into a single crystal three treatments are necessary : the first thermal, the second mechanical, the third thermal. The first treatment is necessary to soften the metal completely and produce new equi-axed crystals of as far as possible uniform size, the average diameter being $^1/_{150}$in. The second consists in straining these crystals to the required amount, and the third in heating the strained crystals to the requisite temperature, so that the potentiality of growth conferred by strain could be brought fully into operation. The most suitable temperature of the first heating was found to be 550 deg. Cent. and the time six hours. The precise degree of strain for the aluminium used was an elongation of 1·6 per cent. on 3in. produced by a stress of 2·4 tons per square inch. The final heat treatment was begun at 450 deg. Cent., and the temperature raised at about 25 deg. Cent. per day up to 550 deg. Cent. It was then brought finally up to 600 deg. Cent. for one hour, in order to complete the absorption of small crystals on the surface, which persistently remained at lower temperatures. On an average, one test piece in four is converted into a single crystal in this way. The boundary at each end extends in the form of an irregular line into the wide head of the test piece. The time required for the single crystal to grow in this way is therefore about 100 hours.

The conditions laid down by us for the production of a single crystal were that every crystal in the complex should be strained a certain small amount, and that one of them should be strained rather more than all the rest. We were originally disposed to think that the crystal which grew and absorbed all the others was the one most highly energised by strain. Subsequent investigations with X-ray analysis, however, have shown that single crystals produced in this way are free from strain, and we have accordingly modified our view and consider that the most highly strained crystal deposits a nucleus free from strain upon which all the other crystals ultimately align themselves, thus producing an unstrained single crystal. How delicate the precise adjustment of strain has to be may be judged from the fact that the precise value has to be determined for each fresh batch of aluminium, even when the metal is of apparently the same composition. As just mentioned, on an average one experiment in four is successful. The result of treating a batch of twenty test pieces in this way was that seven consisted of one crystal, eight of two crystals, four of three crystals, and one of four crystals.

Full details of the way in which the single crystals produced in these test pieces behave when subjected to tensile stress until they finally break are contained in the paper announcing our original discovery —"Proc.," Royal Soc., 1921. Limits of time only permit a brief reference to this work. On the one hand, when composed of small crystals test pieces give uniform results. The ultimate stress varies from 4·5 to 4·7 tons per square inch, and the percentage of extension on 3in. from 36 to 38. The sheet necks slightly at the fracture, which is usually straight. This is the standard of comparison from which the behaviour of single crystals may be judged. Its condition may be regarded as "normal," and a roughening of the surface due to the large number of small crystals is evident. On the other hand, the values obtained in tests on specimens consisting of single crystals varied from 2·80 to 4·08 tons per square inch, while the extension varied from 34 to 86 per cent. These variations in properties were accompanied by striking differences in the method of stretching and the types of fracture produced which provide a means of classifying them. We know to-day that they correspond to differences in the orientation of the single crystals in the various test pieces. Test pieces consisting of two crystals joined end to end give most interesting results. Fracture always takes place across one or other of the crystals but never at the boundary. The influence of one crystal in giving support to the other at the boundary was most marked, and its effect was often noticeable at a distance of 0·25in. from the boundary. Reduction both in thickness and in breadth was much less at this point, and the power to withstand deformation was considerably increased, especially when one crystal slipped to the left and the other to the right. The metal drew down on either side of the boundary and left it as a ridge, sometimes pronounced in thickness and at other times in breadth.

Production of Single Crystals in Bars.

We next proceeded to apply these methods to the production of single crystals in round bars. We found that, provided that the same conditions as to accuracy of machining, correct crystal size, degree of straining, and final heat treatment were maintained, single crystals could also be produced in round bar test pieces, both in diameters of 0·564in. and 0·798in. Single crystal test pieces 9in. long and 0·564in. in diameter have been prepared in this way.

Deformation of these test pieces under tensile stress is very remarkable. On the one hand, the "normal" bar, consisting of small crystals, drew down with a roughening of the surface, a cup and cone fracture, and the maintenance of a circular cross section throughout. On the other hand, when a single crystal was pulled in this way it produced an ellipse. As the test proceeded the ellipse became narrower and narrower in one diameter, while the other diameter remained nearly constant. Presently a point was reached when a characteristic lens-shaped figure was formed. As the bar pulled apart this became smaller and smaller. Eventually fracture took place at each side and ultimately in the middle. The final result was that the fractured surface of each half of the test piece was a very acute ellipse or wedge, the metal being grooved in each case. Characteristic flow lines also made their appearance on the test pieces, corresponding to the slipping of the metal in this remarkable and quite novel way. They may be called "glide-ellipses." Here, again, the properties varied considerably in different specimens, the tenacities ranging from 3·0 to 4·0 tons per square inch and the elongation from 57 to 85 per cent. In some of these experiments the volume of the single crystal exceeded 2 cubic inches, which means that about 7,000,000 crystals had coalesced in their formation.

It has not been found possible to produce single crystal test pieces of square bars. Owing to the shape, these fail to strain uniformly, and on heating crystals grow from the four corners and meet in a line in the middle of the four sides. Some of the crystals were from 2in. to 3in. long and were visible on two adjacent sides. Remarkable effects were obtained on breaking them. In some places the corners became rounded, while in others they were narrowed to a ridge of almost knife-edge thickness. The whole bar became very much twisted and distorted.

As previously mentioned, single crystal test pieces of pure aluminium always pull down under tensile stress on two planes and produce the characteristic "wedge" fracture, and, whatever the original orientation may have been, the final orientation is always the same. Aluminium is a comparatively soft and relatively ductile metal, and it seemed interesting to discover whether it could not be hardened by the addition of an alloying element which does not destroy the cubic symmetry of the crystal and thus might have the property of slipping on only one plane before it fractured. Such an alloy has been found and investigated by Miss Elam in further continuation of our work. By using our method large crystals were grown in an alloy containing 18·6 per cent. of zinc. The load required was 12·2 tons per square inch, producing an extension of 1 per cent. This alloy is very near the limit of solubility of zinc in aluminium, but it is clearly a solid solution. The crystals obtained were not so large as those of aluminium, rarely exceeding 2in. in length and 0·5in. in diameter. They were frequently covered with a surface layer of small crystals, which had to be removed by machining. Small test pieces were made from these. The crystals gave excellent X-ray reflections. The structure appears to be similar to pure aluminium, but has a slightly larger lattice—viz., 4·18 A., compared with 4·06 A. units for the pure metal. Reflections were obtained both from (100) and (111) planes. The angles calculated between each pair of planes showed that the crystals had cubic symmetry.

From tensile tests of single crystals of this alloy and also of a normal bar consisting of small crystals, it was found that there is considerable variation in the breaking loads for different crystals, and they fall roughly into two groups, the one of about 16 tons per square inch and the other from 20 to 21 tons per square inch. It is noteworthy that all the figures for the single crystal test pieces are higher than for the normal bar containing small crystals. This is interesting in view of the opinion that is widely held that the strength of a metal is increased when its crystal size is diminished.

The single crystals of this alloy have quite a definite yield point at about 15 tons per square inch, and in this respect are sharply differentiated from those of the pure metal. The elongation figures are no indication of the true extension of the metal, which was from 10 to 15 per cent., as the majority of these include the fracture, and the shortness of the test piece has as a consequence that the fracture occupied a larger proportion of the parallel portion than is normally the case.

On being extended the crystals formed ellipses, but the alloy did not elongate to the same extent as pure aluminium. The fracture consisted almost wholly of one principal cleavage plane, although there were signs, sometimes hardly noticeable, of a second plane at approximately 90 deg. to it. Both planes made angles of approximately 45 deg. with the axis. It is clear, therefore, that fracture occurred on the plane of maximum shear, which is in strict accordance with theory. It should be pointed out, however, that this is the first time that the requirements of the theory have been realised in practice.

We have carried out compression tests both on round and square bars in order to ascertain whether large crystals can be produced by deformation in this way, followed by heat treatment. The maximum length of test piece possible for a square bar of 1in. section was 6in. for a compression of 1 per cent. measured on 3in. Greater compression of longer test pieces resulted in the bending of the bars. In round bars of 1in. diameter the maximum length was found to be 5in. for a compression of 1 per cent. On heating these test pieces large crystals were produced in all cases. A cross section of the round bars showed them to consist of not more than three crystals in most cases. The square bars had a core of small crystals surrounded by four large crystals which met in the centres of the faces of the square. Some of these crystals were 3in. or 4in. in length. It is clear, therefore, that the capacity of aluminium to form large crystals is not the result of tensile strain *per se*, but is the result of strain generally. Miss Elam has also produced an aluminium tube consisting of one crystal by the method of critical strain followed by heat treatment. This also when deformed in tension distorts in such a way as to produce an elliptical hole, showing that the method of deformation is the same as in the case of solid bars. This tube of aluminium was used by Farren and Taylor in comparing the heat evolved on distorting a single crystal of aluminium with that of a polycrystalline bar. They have shown that about 95 per cent. of the work of deformation appears in the form of heat in the case of the single crystal as compared with from 92 to 93 per cent. in the case of the polycrystalline bar. The difference between these represents the influence of the crystal boundary.

Undoubtedly the most remarkable property of a practical nature of the single crystal test pieces is their malleability and ductility, a fact which is in complete conformity with their uniform structure. In one case we rolled down a single crystal from its original thickness, 4·0in. by 1·0in. by 0·125in. to 0·0094in., corresponding to a reduction in thickness of 93 per cent. This rolling was done without annealing at any stage. The strip, although hardened, was still perfectly malleable, and the operation could have been continued further had the rolls permitted of it. This malleability is far in excess of that in the sheet consisting of small crystals.

The severest form of mechanical work is wire-drawing, and experiments with single crystals showed that these can be drawn from a diameter of 0·564in. to 0·02in. and still remain perfectly ductile. In order to obtain a sufficient length of bar for this purpose test pieces 16in. long were prepared with a parallel portion of 6in., diameter 0·564in. Five such bars were completely converted into a single crystal over the parallel portion. In a given case a test piece was machined 3·5in. long and 0·4in. in diameter. This was drawn down cold to a length of about 112ft. After this process it was still sufficiently ductile to pass the Post Office test for aluminium wire.

One of the most striking tests which can be carried out on these large crystals is the Brinell ball-hardness test, and the results are particularly interesting when carried out on a bar where there are several crystals of sufficient size to enable the test to be made on each crystal. In no case does the round ball produce a round impression. The indentation is nearly always square, with slightly rounded corners. The orientation of these changed from crystal to crystal, corresponding to the different orientation of the crystals themselves. This remarkable test shows in a striking way that the crystals are not isotropic, but yield more easily along certain planes. Broadly speaking, therefore, we may say that we can produce a square hole in the crystal by means of a round ball.

When, as in certain cases, the pieces broken in tensile test were heated recrystallisation was brought about. The temperature at which this began, and the size of the new crystals produced, depended on the amount of deformation of each particular crystal. Those which had been least deformed produced the largest new crystals. It was always found that the new crystals grew from the region of maximum stress, *e.g.*, from the fracture itself and from scratches on the surface. The smallest of the new crystals are found at the fracture, and the size increases up to the shoulders, where the stress has been least.

The new crystals were not equiaxed, but were elongated in the direction of pulling, and they frequently sloped sideways, as if following the direction of the slip-bands. Some of the new crystals showed well-marked twins, which are somewhat rare in aluminium and resemble those in copper and brass. One example was obtained in which the twin crystal completely penetrated the sheet.

Professor Edwards and Mr. Pfeil have applied our method with great success to the production of large crystals of iron. This fact is particularly interesting, because the crystal lattice of iron is different from that of aluminium and the metal does not distort in the same way. Iron has a body-centred cubic lattice, whereas that of aluminium is face-centred. The problem has proved more difficult to solve. In the first place, the complete removal of carbon from the iron is necessary. This the authors accomplished by passing hydrogen over the metal in a furnace of 950 deg. Cent. for a prolonged period. The required grain size is approximately 120 per square millimetre. The distortion required is decidedly higher than in the case of aluminium, viz., about 3·25 per cent. The final heat treatment takes several days at about 880 deg. Cent. The large crystals of iron, however were always covered with a surface layer of fine crystals; this had consequently to be removed before the large crystals were visible. When, however, distortion is produced by rolling, absorption of the small surface crystals can take place on heating.

The authors have carried out a number of tests on single crystals produced in this way, and have found that in the great majority of cases the tenacity is about 10 tons per square inch, which is about half the value for the same metal in the finely crystalline state. In one case, however, a single crystal had a tensile strength of 15·38 tons per square inch. In the case of iron they found a primitive limit of proportionality of about 2 tons per square inch, which is little more than a quarter of that of the finely crystalline metal. No relation was found between values for the primitive limit of proportionality and those of tensile strength. Elongations were very variable, as also were the types of fracture.

Reference must also be made to two papers by Mr. Goucher on the properties of tungsten single crystals. Tungsten furnishes an interesting example of a metal which can be obtained in the form of a single crystal wire by imposing the correct strain and heat treatment at the same time. Mr. Goucher has found that by heating drawn tungsten wires to a high temperature large crystals are developed with random orientation of the crystal axes, many of which occupy locally the complete volume of the wire.

The foregoing results show in a striking manner the difference in properties between a metal as ordinarily prepared consisting of small crystals and the same metal in the form of a single crystal test piece. On the one hand, a round bar of the former when pulled in tension maintains its circular cross section throughout, and finally breaks with a cup and cone fracture; a square bar of the same metal pulls out and gives a square fracture. On the other hand, in the form of a single crystal test piece, a soft metal like aluminium pulls out along two conjugate planes forming an ellipse and ultimately breaks with a very characteristic double-wedge fracture. If the aluminium is hardened by the introduction of such a metal as zinc, so that it exhibits greater resistance to tensile stresses, it pulls out almost entirely on one plane and the result is a bar, the fractured surfaces of which are almost exactly at 45 deg. to the axis of the test piece. It is clear, therefore, that the circular fracture of a polycrystalline round bar and the square fracture of a polycrystalline square bar are not due to an inherent property of the metal crystals themselves, but to the fact that they consist of a vast number of minute crystals oriented at haphazard which yield in many directions and produce the effect of an isotropic material. The isotropy, however, is due to compensation and not to the properties of the metal crystal.

The anisotropy of the metal crystal is equally strikingly shown by the production of a square indentation (with rounded corners) produced by a round hardened steel ball. Here again the yielding of the metal is according to its crystal symmetry, the hardness not being equal along all the planes. Another most remarkable feature of the single crystal test piece is its ease of slip. In this respect it possesses this property to such a pronounced degree that it may be regarded as a different metal from the same metal in the polycrystalline state.

A New Method of Washing Filtering Material.

A NEW means of washing the filtering medium of mechanical filters, such as are employed in waterworks for the filtering of water, has been devised and patented by Mr. Alfred E. Smith, the Engineer and Manager to the Ilkeston and Heanor Water Board. The device is, the author claims, particularly applicable to filters dealing with a water containing a high percentage of bacteriological impurities, in which a thorough washing of the medium is essential, and to filters used for the removal of lime in suspension from softened water. The device is, we understand, working very satisfactorily in connection with some of the Board's filters.

The arrangement as applied to a 10ft. diameter gravity filter capable of dealing with 8000 gallons of water per hour, is shown in Fig. 1. A wash water pipe is arranged either outside or inside the filter. As shown on the drawing it is outside the filter. This pipe is provided at intervals with fan-shaped nozzles which just project into the filtering medium at a few inches below the upper surface of the latter, since it is found that practically the whole of the suspended matter in water being filtered is arrested by the first few inches of filtering medium. The fan-shaped nozzles force the wash water through that portion of the filtering medium and, it is stated, insure a thorough washing with a minimum quantity of water.

The filtering medium is supported on a system of pipes

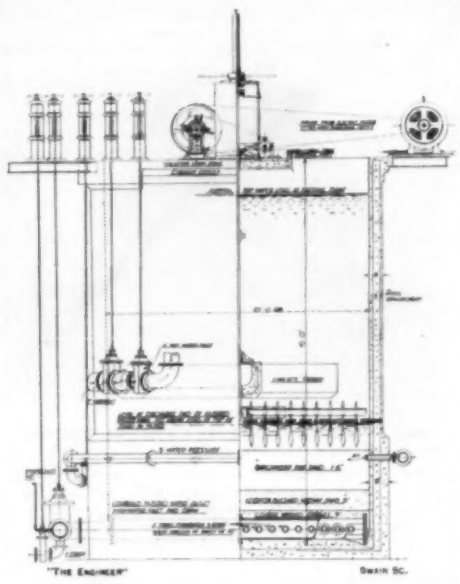
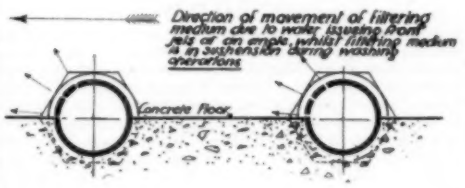


FIG. 1—FILTER FITTED WITH THE SMITH SAND WASHER

provided with a number of rows of fine holes arranged at an angle. These pipes serve two purposes:—(1) They collect the filtered water during filtration; while (2) during washing operations, a reverse flow of water is passed through holes in them, so that it is forced upwards into the filtering medium. The arrangement of these pipes is shown in Fig. 2.

The holes, or fine slots, in the pipes are, it will be noted, drilled at an angle. During washing operations, a flow of wash-water passes into the pipes and through the holes or fine slots, which has the effect of putting the whole of the filtering medium in suspension. The water spurting through the holes or fine slots in the pipes at an angle


Direction of movement of filtering medium due to water issuing from jets at an angle, whilst filtering medium is in suspension during washing operations
Concrete Floor

ENLARGED SECTION THROUGH A.A

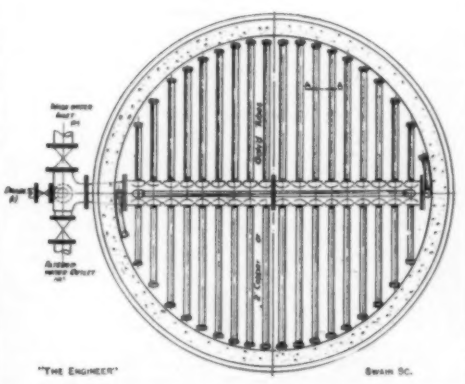


FIG. 2—ARRANGEMENT OF MEDIUM-SUPPORTING PIPES

causes the suspended filtering medium to move in the same direction as the jets of water issuing from the holes, and the rotary movement imparted to the suspended filtering medium in this way is further assisted by a system of mechanical rakes which is lowered into, and can be rotated in the filtering medium, with the results that the filtering medium is made to occupy a different position after each washing, and that on reversing the direction of rotation of the rakes a thorough breaking up of the filtering material is effected. The latter, the inventor points out, is an important feature, for any of the filtering medium in a filter which is not thoroughly washed may become a breeding ground for bacteria, and will also reduce the quantity of water filtered by the unwashed filtering medium becoming solid in parts.

The mechanically-operated rakes are lowered into the filtering medium during the washing operations, and are first rotated in the same direction as the filtering medium is being rotated by the water forced in from the bottom system of pipes, thus assisting the movement of the medium. After being in use for a few minutes the direction of rotation of the rakes is reversed by means of a reverse switch and motor or gearing, which effects a further cleaning of the filtering medium.

During filtering operations, the rakes are raised, so that they are above the surface of the filtering bed. They are so raised to prevent capillary action which might otherwise take place down their sides, if they were left in the filtering medium, and to avoid accidental moving of the medium during filtration, which would cause voids in the medium and the spoiling of the filtering bed.

The concrete trough, seen above the filtering material in Fig. 1, has two purposes, viz.:—(*a*) The even distribution of the inlet or unfiltered water over the surface of the filtering medium during filtration; and (*b*) during washing operations the collection of the wash water containing the arrested impurities. The trough is raised above the rakes to prevent the finer filtering sand being washed away with the impurities during washing operations, its height above the surface of the bed being varied a little according to the specific gravity of the medium used.

A TRAVELLING POST-GRADUATE SCHOLARSHIP.

THE Council of the Institution of Mining Engineers has accepted a generous offer, made by Mavor and Coulson, Ltd., of Glasgow, of a sum of £300 for a further year, for a post-graduate travelling scholarship, which must include Canada or the United States of America in the itinerary of the selected candidate.

The award will be made by the Council of the Institution on the recommendation of a committee of selection, and will be regulated by the following conditions, among others:—(1) Value, £300 for one year. (2) Open to British subjects over twenty-three years and under twenty-seven years of age who are student members or associates of the Institution of Mining Engineers, who have graduated in mining at a university or college, or taken the associateship of the Royal School of Mines, and who have had at least twelve months' underground experience in a colliery. (3) Candidates will be required to submit a thesis on the subject of their own choice connected with underground operations in coal mining. The thesis must be accompanied by a declaration that it is the sole work of the candidate. Credit will be given to a candidate for knowledge of a modern foreign language and also for evidence of facility in freehand sketching. (4) The successful candidate will be required to devote one year to the special study by underground investigations of the methods practised in the actual mining of coal and in the transport of coal from the face to the main mechanical haulage; to follow a pre-arranged itinerary specifying the collieries to be visited, subject to the condition that not more than one month shall be spent at any individual colliery; at least one month shall be spent in Canada or in the United States of America; and a candidate who knows a foreign language may be required to spend not less than two months on work on the continent of Europe. (5) The itinerary shall be approved and may be drawn up by the Council, which will arrange for access to the collieries to be visited. (6) The scholarship will be payable in advance in four quarterly instalments of £50 each; an instalment of £50 will be paid at the time of booking a passage to Canada or the United States of America; and a final payment of £50 will be made at the end of the last quarter when the final report has been received by the secretary and approved by the Council.

Applications in respect of the award must be in the hands of the secretary of the Institution, Cleveland House, 225, City-road, London, E.C. 1, from whom further particulars may be obtained, by September 1st, 1926.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.

A MEETING of the Institution of Municipal and County Engineers will be held in the Scottish District at Kilmarnock, on Thursday, Friday and Saturday, June 10th to 12th inclusive.

On the Thursday evening at seven o'clock there will be a business meeting of the district in the Lecture Hall of the Dick Institute, London-road. On the Friday morning at 10.30 o'clock the members will be received by the Provost, Magistrates and Councillors of the Burgh of Kilmarnock, in the Lecture Hall of the Dick Institute, and, thereafter, there will be discussions on the following papers:—(1) "Notes on Municipal Works in Kilmarnock," by William Dunbar, burgh surveyor, Kilmarnock; (2) "Description of Quarry Plant at Parkthorn Joint Quarry," by James Lang, county road surveyor, Kilmarnock; (3) "Regional Town Planning," by W. A. Macartney, A.M. Inst. C.E., city engineer, Edinburgh; (4) "Maintenance of Unclassified Roads: The Cry of the Rural Districts," by William Ballantine, district road surveyor, Falkirk.

Meanwhile, for the ladies of the party, a visit to the Child Welfare and Maternity Home, and to a silk works. Luncheon, at the invitation of the Provost, Magistrates and Councillors of the Burgh of Kilmarnock, will be partaken of in the Art Gallery, London-road.

In the afternoon visits will be paid to Roads, Housing Sites, Kay Park and Howard Park, and in the evening, at 7.30 o'clock, the annual dinner of the Institution will be held at Lauder's Restaurant.

On the Saturday morning, at 10.15 o'clock, there will be alternative visits to:—(*a*) The Parkthorn and Hillhouse Quarries; (*b*) the works of Glenfield and Kennedy, Ltd., and afterwards to the Amlaird Filters; and (*c*) the works of Blackwood, Morton and Sons, Ltd., art carpet and rug manufacturers.

NOTES ON SWISS HYDRO-ELECTRIC SUPPLY.—CORRECTION.—The author of the article on "Swiss Hydro-electric Supply" in our last issue was Mr. H. A. Sieveking, not Mr. Alfred R. Sieveking.

A Portable Arc-Welding Plant.

THE portable arc-welding and cutting plant illustrated in Fig. 1 has been brought to our notice by Siemens-Schuckert, Ltd., of 109, Kingsway, W.C. 2. The welding generator, motor starting and regulating apparatus and instruments are all contained in a single housing, which is waterproof, and the plant is claimed to be specially suited for outdoor work. The welding current can be regulated between the values of 100 and 200 ampères,

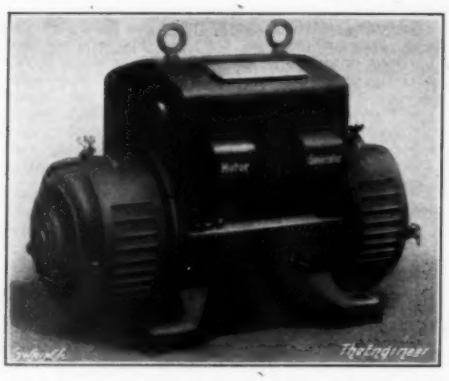


FIG. 1—PORTABLE ARC-WELDING PLANT

and the pressure between 20 to 45 volts, the open circuit pressure being 95 volts. The plant is therefore quite suitable for use with flux-covered electrodes requiring a high voltage for striking the arc. By means of a shunt regulator, which is connected to the separately excited field circuit, the open circuit pressure can be adjusted between the values of 50–95 volts, the corresponding pressures across the arc then being 20 to 45 volts. The design is such that the voltage may rise quickly after a short circuit, and without a sudden rush of current,

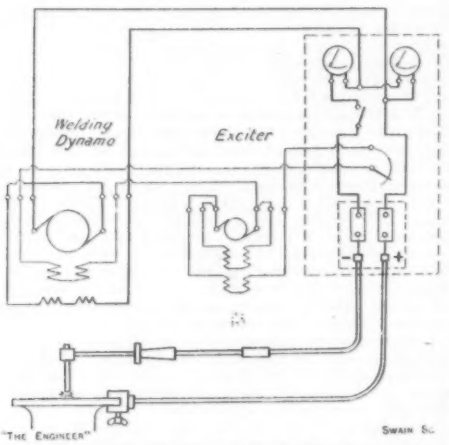


FIG. 2—CONNECTIONS OF ARC-WELDING PLANT

since the makers contend that the ordinary reverse compound-wound drooping characteristic machine is sluggish; its voltage does not rise sufficiently quickly, and a sudden rush of current is experienced. On that account a reactance or stabiliser must be connected in the welding circuit. With the machine under consideration the voltage drop from open circuit to welding voltage is obtained by weakening the separately excited field by armature reaction and a reverse series wound interpole field. The brushes must, therefore, be placed out of the

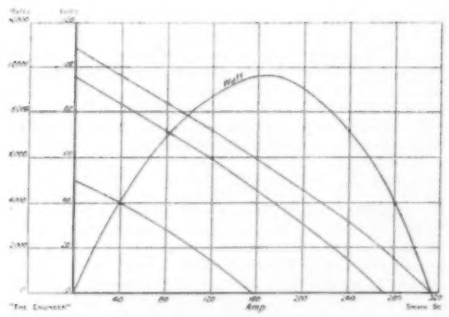


FIG. 3—CHARACTERISTIC CURVES

neutral position, and the generator is consequently fitted with wide interpoles.

Fig. 2 shows a diagram of connections of the generator. The separately excited field winding is connected to an exciter or to a direct-current supply. The open circuit voltage is easily regulated by means of a shunt regulator in series with the excitation circuit. To interrupt the welding circuit it is only necessary to disconnect the excitation circuit. Fig. 3 shows the characteristics on the welding generator. It will be seen that by means of a shunt regulator the welding current can be adjusted to any value between the maximum and minimum values shown by the curves. The curves also show that when the arc is lengthened or shortened, the current variations are small and well within the practical limits. Further, it will be seen that the short circuit current is quite low and well within the range of sparkless commutation. The separate excitation has constant value and remains constant even with a short circuit and when the field is practically wiped out through armature reaction. As no wasteful series resistances or choking coils are employed, the plant has a high efficiency, and it is claimed that unsteadiness of the operator's hand is not accompanied by sudden changes in the current. The generator is designed to maintain a steady arc, and therefore to produce good welds.

The machine can also be used intermittently for cutting mild steel or cast iron plates with a thickness up to ½in., whilst for cutting thicker plates two or more generators can be connected in parallel. The motor may be designed for use on any standard direct-current or alternating-current circuit, but when the supply is an alternating-

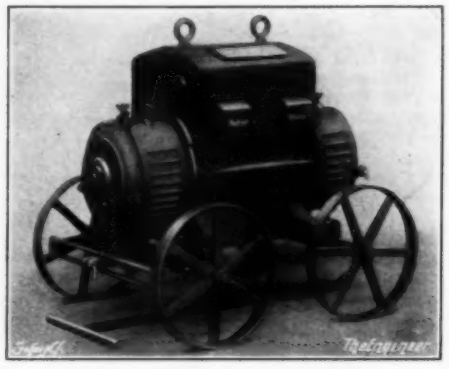


FIG. 4—WELDING PLANT MOUNTED ON TROLLEY

current one the generator is generally combined with an exciter. As the machine is fitted with ball bearings, it will run satisfactorily in a slightly inclined position. The complete unit can either be mounted on a trolley—as shown in Fig. 4—or it may be supplied as a stationary set—as shown in Fig. 1. When the machine is worked from a direct current the motor starter is fitted with a no-volt release. In the case of an alternating-current supply a squirrel-cage or slip-ring motor is supplied. When bare wire or medium flux-covered electrodes are used the positive terminal is connected to the work, whilst when heavily flux-coated electrodes are employed, and when a high depositing speed is required, the positive terminal is connected to the welding tools. A special feature of the plant is that the motor generator is always kept at the same temperature by means of forced ventilation, another advantage claimed being that no adjustments are needed during the welding process.

Safety Working in U.S. Mines and Quarries.

EXTRAORDINARY records of large industrial production with no loss of time occasioned by accidents, were revealed in connection with the announcement recently made by Secretary Hoover of the United States Department of Commerce, of the names of mines and quarries adjudged winners of the national safety competition, held under the auspices of the Bureau of Mines, for the bronze trophy "Sentinels of Safety," provided by the "Explosives Engineer Magazine." A Maryland quarry operated 350 days and worked 202,663 man-hours during 1925, with no loss of time from accidents. Four other quarries, situated in Indiana, Tennessee, New York and California, also operated with no loss of time due to personal injuries. In addressing congratulatory letters to the winners, Secretary Hoover visualised the great economic benefits both to producers and consumers of coal, ore and stone, from this nation-wide effort to prevent accidents, in which during its first year more companies and individuals had participated than in any other organised safety contest.

Nearly 300 of the larger mines and quarries participated in the competition, the contestants being divided into five groups:—Anthracite mines, bituminous coal mines, metal mines, mines producing non-metallic minerals, and quarries or open pit mines. A replica of the trophy is awarded to the mining operation in each group sustaining the smallest loss of time from accidents in proportion to total time worked during the year. Determination of the winners was made by a jury of award comprised of officials of various mining and quarrying associations, the National Safety Council, and the American Federation of Labour, based on a tabulation of mine accident data prepared by the Bureau of Mines. A feature of the competition was the awarding of a certificate of honour, signed by the Director of the Bureau of Mines, to every employee of each of the winning mines and quarries for their share in the low accident records made by their companies.

The winner in the anthracite group was the Upper Lehigh Mine, Upper Lehigh, Pa., operated by the Hazle Brook Coal Company. In that group, honourable mention was accorded the Midvalley Mine, Wilburton, Pa., operated by the same company. The winner in the bituminous coal mining group was No. 6 Mine of the United States Coal and Coke Company at Gary, W. Va. Honourable mention was given the No. 3 Mine of the same company, also situated at Gary; and the Rossiter No. 4 and 5 Mine, at Rossiter, Pa., operated by the Clearfield Bituminous Coal Corporation. In the underground metal mining group, the New York zinc and lead mine of the New York Mining Company, at Picher, Oklahoma, was adjudged the winner. Honourable mention was accorded the Beaver lead and zinc mine of the Commerce Mining and Royalty Company, at Carden, Oklahoma; the Velton zinc ore mine of the Eagle-Picher Lead Company, Bricefield, Mo.; the lead mine of the St. Louis smelting and refining works of the National Lead Company, at St. François, Mo.; and the Goodwin lead and zinc mine of the Eagle-Picher Lead Company at Picher, Okla.

In the group of underground mines producing non-metallic minerals, the trophy was awarded to the Lower gypsum mine of the United States Gypsum Company, at Gypsum, Ohio. Honourable mention was accorded the Ironton underground limestone quarry, operated by the Alpha Portland Cement Company, Ironton, Ohio; the Crystal City sand mine of the Pittsburgh Plate Glass Company, at Crystal City, Mo.; the limestone underground quarry of the Alpha Portland Cement Company, at Milltown, Indiana; and the Bell underground high calcium limestone quarry of the American Lime and Stone Company, at Bellefonte, Pa.

In the quarry and open pit mine group, the winner was the Security Quarry of the North American Cement Corporation, at Security, Md. Honourable mention was accorded the cement rock quarry of the Louisville Cement Company, at Speed, Ind.; the limestone quarry of the Dixie Portland Cement Company, at Richard City, Tenn.; the Cementon Quarry of the Alpha Portland Cement Company, at Cementon, New York; and the andesite quarry operated by the City of Los Angeles Harbour Department on Catalina Island, Calif.

Companies operating a coal mine employing fifty or more men underground, a metal or other mine employing fifty or more men underground, or a quarry or open pit mine employing twenty-five or more men in the pit were eligible to compete for the trophies. The trophy, which is the work of Begni del Piatta, designer of the Navy and Marine Memorial to be erected in Washington, portrays in bronze a mother and child greeting the father upon his safe return from work. The names of the mines and quarries which win the right to hold the trophy for a year will be engraved on the pedestal. On the remaining sides of the pedestal are panels emblematic of coal mining, metal mining, and quarrying and open pit mining. The trophies will be bestowed upon the winning companies at the International First-Aid Meet, to be given under the auspices of the Bureau of Mines at San. Francisco, Calif., early in September.

British Engineering Standards.

STANDARD SPECIFICATIONS FOR PAINT MATERIALS.

THE British Engineering Standards Association has recently issued British standard specification No. 217, 1926, "Red Lead for Paints," and No. 242, 1926, "Refined Linseed Oil for Paints." These specifications contain clauses regulating the composition, together with standard reception tests for the purchase of red lead and refined linseed oil, and appendices giving the methods of carrying out the tests. The specifications have been prepared at the request of the paint manufacturers by a committee representative of both buying and manufacturing interests, and, as in the case of all British standard specifications, they will be reviewed as experience in their working or progress in the industry renders it necessary, and revised issues will be published from time to time. Copies of these specifications may be obtained from the B.E.S.A., Publications Department, 28, Victoria-street, London, S.W. 1, price 1s. 2d. each post free.

BRITISH STANDARD TABLES OF BRINELL HARDNESS NUMBERS.

Standard tables of Brinell hardness numbers have been prepared and issued by the British Engineering Standards Association as B.E.S.A. Publication No. 240-1926. The tables are accompanied by recommendations regarding the accuracy of the apparatus to be used for the test, the preparation of the test specimens, the magnitude and application of the load and the method of specifying the hardness.

It is hoped in a later edition to include a specification for the hardness of steel balls used for Brinell testing.

Copies of this new publication may be obtained from the B.E.S.A. Publications Department, 28, Victoria-street, London, S.W. 1, price 1s. 2d. post free.

BRITISH STANDARD SPECIFICATION FOR RAILWAY RAILS.

A new edition of the British standard specification for flat-bottom railway rails, Report No. 11—1926, has been published by the British Engineering Standards Association. The revision of the specification was necessitated by the revision of the B.S. flat-bottom rails from 25 lb. to 100 lb. per yard inclusive, particulars of which were issued as a provisional measure in 1924 in Report No. 11A. Modifications have been made in the table of falling weight tests to meet the changes in the design of the rails, the height of the drop being altered in many cases. A maximum permanent set is no longer specified.

A noticeable point in the new edition is that the maximum content of sulphur and phosphorus is now slightly higher than that permitted in the 1922 specification.

Full-size drawings of the rails are given, and, in addition to the sections from 25 lb. to 100 lb. per yard issued in 1924, four heavier rails of 105 lb., 110 lb., 115 lb., 120 lb. per yard respectively, are now included. Copies of this publication No. 11—1926, bound in stiff cloth covers, may be obtained from the B.E.S.A. Publications Department, 28, Victoria-street, London, S.W. 1, price 5s. 4d. post free.

IN addition to the particulars given in the annual Railway Returns, there are those covered by the Tramways and Light Railways Returns. The annual Blue-book as to those has recently been issued as a Stationery Office publication, price 15s. It shows that there are 2605 miles of tramway and light railways, of which 1859 miles are worked by Local Authorities. The capital invested in them amounts to £94,552,372; the receipts last year were £28,737,639, and the expenditure £22,733,155. The number of passenger journeys was 4620½ millions, which was 177 millions more than in the previous year, and the car mileage was 378 millions, of which 99.59 per cent. was electrically operated.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

General Situation.

MOST of the iron and steel works in this area are now at a standstill. The coal supplies held by engineering and manufacturing works in the Midlands and Staffordshire are dwindling; and no settlement of the mining dispute is in sight. An increase in the number of idle works seems, unhappily, to be inevitable unless larger supplies of fuel are forthcoming. The disorganisation of the collection and distribution of goods by the railway companies is also contributing to the depression of industry. The larger works, with big reserves of coal, may be able to carry on normally for a short time longer, but already short time has had to be instituted in many factories. At the weekly meeting of the Midland iron trade in Birmingham to-day—Thursday—a far from optimistic view was taken of the future, though it was admitted there are prospects of increasing business when once the strike is over and things get back to normal. Despite the factors which combine to repress consumption, more stringency is apparent in the iron trade, and values tend to increase, especially in the case of business accepted for immediate delivery.

Raw Iron Values.

Blast-furnaces, being large consumers of coal, are, owing to the continuance of the colliers' strike, necessarily out of action. The only exception in this area is a furnace at Staveley, in Derbyshire, which is operating on slack blast to economise fuel and producing on a reduced scale, chiefly for the supply of its own pipe-casting foundries. The trifling surplus available is saleable in small quantities, but the furnace cannot continue long in operation. Most of the furnaces are damped down, the preference of damping down rather than blowing out being based on the hope that the coal stoppage may be of short duration. By exhausting their fuel the furnaces could have continued for some time making iron; but the policy of utilising fuel for keeping the furnaces alight in readiness for a restart was preferred. On 'Change in Birmingham to-day—Thursday—it was reported that a few smelters had limited stocks of pig iron for disposal. They were not anxious sellers, however, and the majority wanted increased prices. Sellers who were able to give early delivery expected in some cases an advance of half-a-crown on the pig iron prices ruling before the strike. Thus Derbyshire No. 3 foundry was priced at about £3 9s. at furnaces. Some sellers did not think it worth while to exact the uttermost, which, in the straitened state of the market, consumers must needs pay if they would secure supplies. Transactions referred only to small tonnages and were in the nature of accommodation lots for regular customers. Price variations had, in these circumstances, no general significance. East Coast hematite was obtainable at about £3 15s. to £3 16s. at furnaces.

Steel.

There is still a little business being done in steel. The strike has naturally held back numerous orders, but large engineers and others get sufficient inquiries to indicate that there is ample business available to keep the iron and steel works at least as busy as they were through the early months of the year. Constructional engineers and builders are operating on a restricted scale, confronted by almost insuperable difficulties. They are, however, calling for material in small lots, and in many cases are glad to secure native material to replace continental, of which they cannot get delivery owing to the restricted transport facilities. Most of the steel works are out of action, but a number of Midland iron mills specialising in the re-rolling of steel are able to continue, having some fuel available, and, by means of gas heating, they are making the most economical use of their coal. To some extent electric driving is also utilised, and this source of energy will be available for some time. Quick supplies of steel sections were offered on 'Change to-day at a premium of 5s. on the basis of £7 2s. 6d. fixed by the Association a short time since. Small steel bars were quoted at £7 15s. as before. Ship, bridge and tank plates, £7 17s. 6d.; and boiler plates at £11. Several strip mills are still operating, and in this case the old price of £10 10s. at works holds good. Billets were obtainable in a few quarters at £6 2s. 6d., but those who had any quantity to dispose of asked £6 5s., a price consumers did not appear disposed to accept. The tin-plate trade is idle, and the business in steel scrap is entirely suspended for the present.

Finished Iron.

There is little demand for finished iron and many of the Staffordshire mills are idle. Engineers are held up and their consumptive requirements of best-grade bars has dwindled almost to vanishing point. Producers realising there is nothing to be gained from price adjustments, continue to quote the basis rate of £14 for marked iron. Makers of Crown and nut and bolt quality iron in this district are very discouraged. Even if there were business to be got, they could not compete with the Lancashire and Belgian makers, and the outlook, even when things become normal, is very obscure. Crown bars of Staffordshire make continue to be quoted £11 to £11 10s., and nut and bolt bars £10 to £10 10s. Wrought iron gas tube strip sells slowly at £12 5s. to £12 10s. per ton.

Galvanised Sheets.

The one fairly active department is that of galvanised sheets, which are still being produced by some of the largest works. One big concern, which has had to cease operations, has fairly heavy stocks that can now be disposed of at £15 15s., a rise on the recent figure of 10s. per ton. Sheet orders come in quite satisfactorily, and there are plenty of inquiries about.

Continental Material.

One effect of the restricted transport is the inability to obtain from the Continent large quantities of semi-finished steel, as well as finished bars, joists, &c., bought before the strike. This will accelerate the stoppage of certain Black Country re-rolling mills, and also restrict building operations, hampering at the same time other industries utilising foreign cheaper material.

Production Figures.

The statistics of production in April show an output of steel totalling 661,000 tons and of pig iron 539,100 tons. This is a reduction of 37,000 tons of steel and 29,000 tons of pig iron as compared with March. The steel output, however, exceeds the pre-war production of 1913 by nearly 30,000 tons, and the April drop is attributed merely to the occurrence of the Easter holidays.

Warwickshire Pit Owners' Offer.

I am given to understand that the Warwickshire colliery owners feel that the Government proposals, whilst objectionable from many points of view, are, in addition, so weighted with administrative details and questions of policy which will take weeks to discuss that it behoves each district to find its own solution of the difficulties. Under these circumstances they are stated to be prepared to open the pits after the Whitsuntide holidays at the same rates of pay and on the same conditions as were in vogue prior to May 1st, save that an eight-hour day is worked, the proposal, of course, carrying with it the withdrawal of the 14·2 per cent. which was paid to contractors and pieceworkers when the hours were altered from eight to seven, so that the lost hour might not mean an actual reduction in wages received per week. The proposal would mean no reduction in weekly earnings, but, as the results of the working of the pits with an extra hour would be more advantageous, the men would automatically benefit by the increased percentage which would become payable upon the basis wage, as that is dependent on profits earned.

Cannock Chase Coalfields.

The coal strike has already lasted longer than Cannock Chase miners had anticipated, yet the rejection by the Miners' Executive of the Government's proposals for a reduction in wages or a lengthening of working hours appears to meet with their general approval. Nevertheless, they are sorely disappointed that it is necessary for them to continue the struggle, which they were hoping would be finished before Whitsuntide. The miners' strike funds are exhausted, and upwards of 4000 miners are receiving relief on loan from Cannock Board of Guardians. Voluntary relief committees have been set up in various parts of the district and meals are being provided daily for the children. Thousands of miners and their families are raising a little income by picking coal from the dirt mounds at the different collieries and selling it.

Machinery for Getting Coal.

Speaking at a recent meeting of the South Staffordshire and Warwickshire Institute of Mining Engineers, Mr. S. F. Sopwith, general manager of the Cannock Chase Collieries, Ltd., the President of the Institute, said that undoubtedly the mining industry at present required a prescription for cheap production, and there was no doubt that further developments of machinery for getting coal were essential. Referring to particular types of coal cutters, Mr. Sopwith said that at his own Cannock Chase colliery, twenty-seven years since, they started up a machine driven by direct current at 110 volts driving a disc cutter. It was a very excellent machine, and it was wonderful to see how very little difference appeared in the machines now made. He presumed that it was owing to labour conditions, and the comparative cheapness of labour, that machine mining had not been developed to any great extent until recent years.

New Technical College.

Wolverhampton is doing all in its power to encourage the youth of the district to study the technicalities of the trades in which they find themselves. On Friday last Princess Mary, Viscountess Lascelles, opened the engineering and technological block of the new Technical College in Wulfruna-street which has just been completed, with the object of improving and extending the facilities of technical instruction for the increasing number of students who year by year present themselves for enrolment. Comprised in the new block are two wings, north and west. On the ground floor of the north wing are an engineering laboratory containing fixed electrical and mechanical machinery, and senior laboratories mainly for bench experiments. The first floor contains a woodwork shop and junior mechanics' laboratory, and the second floor is given over almost wholly to an engineering workshop. In the west wing there is accommodation on the ground floor for a dark room for photographic work, a lecture room, a general chemical laboratory, and a small chemical laboratory for senior work. A metallurgical laboratory, supplied with gas-fired furnaces, a room for microscopic work, class rooms, and temporary administrative offices are features of the first floor; and the second floor comprises class rooms for a variety of purposes and a room for photo-printing. There is also a foundry with a core bench, a casting pit for occasional work, a cupolette, two gas-fired furnaces for non-ferrous metals, and a small travelling crane. The new buildings have been provided at a cost of £39,000, borne by the education authorities of Wolverhampton and Staffordshire.

Midland Firm Secures Large Contract.

The Rural District Council of Uxbridge, in the county of Middlesex, has entered into a contract with G. Percy Trentham, Ltd., of Birmingham, for the main sewerage connecting the parishes of Harefield, Hillington East and Ickenham, with extensive sewage disposal works, pumping main and pumping station, the total amount of the contract being £92,334. It is anticipated that the work will take fifteen months to complete.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Outlook.

THIS week has been particularly notable for the poor attendance on 'Change here. Normally Whitsuntide in the Manchester district shows up very badly from the business point of view, for the business week usually consists of one full day and one, or perhaps two half days, so that actual trade amounts to very little. It is quite correct to say, however, that Whitsuntide this year has made little or no difference to the volume of business done, for the coal stoppage has so effectively brought the iron and steel trades to a standstill that things could not conceivably be worse than they have been during the last week or two. Except in one or two branches, the engineering industry is not by any means satisfactorily employed, and even where the state of the order books is moderately good, there seems to be a general disposition to proceed cautiously in view of the present situation. Manufacturers of heavy electrical machinery, textile finishing machinery, and some constructional engineering firms are, perhaps, the best situated, but in the case of the last-named the situation in respect of supplies of steel is creating considerable difficulties.

Non-ferrous Metals.

At the time of writing there is a steadier tone in the non-ferrous metal market generally, and few fluctuations of any serious consequence have occurred. Most of the metals are, of course, affected by the coal dispute and its industrial effects, and it is very unlikely that, until a settlement is reached, any improvement in the demand will be experienced. Tin, as has been the case for some time now, has been the most spectacular in its movements, and wide fluctuations have characterised prices during the week, although at the moment they seem to be steadier. The demand for copper, both here and in the United States, has been at a low ebb, and values have been affected in consequence, although there has since been a slight recovery. The position of lead has been influenced by an improvement in the European demand and by the labour situation in Australia. As a result, prices have kept up very well, with no appreciable change on balance. Outside influences have also affected spelter values, which have been steady throughout the week.

Iron.

So far as one can see, there is very little change to record in the position of pig iron, both buyers and sellers having no other course open to them than to mark time. As was stated in this column last week, pig iron makers selling on this market advanced their prices by about half-a-crown a ton. This increase has been fully maintained, although no further rise has to be recorded. Blast-furnaces are still damped down and will be maintained in that condition as long as fuel supplies permit. The general opinion, however, is that even with a settlement of the coal trouble, not all of them will be put into blast again until makers are in a position to gauge the situation fully from the point of view of production costs. It is stated that selling prices, prior to last week's advance, were either at or below costs of production, and for that reason it is not anticipated that producers will so readily relinquish the extra 2s. 6d. per ton that is now being quoted. Some makers are said to be entirely without stocks of pig iron—certainly some of them have withdrawn quotations altogether—whilst others are not too well situated in this respect. Sales are being effected at the higher prices, but sellers, as a rule, are limiting them to regular buyers. The manufactured iron trade is very dull, but quotations are unchanged, Lancashire Crown bars offering at £11 per ton, delivered Manchester or equal, and second quality bars at £9 15s.

Steel.

In the steel trade the week has been entirely uneventful in every sense of the word. Generally speaking, the rolling mills are still on stop and, considering the enormous amount of fuel a week's operations mean in the case of a large plant, are likely to remain so until there is a return to normal conditions. Contrary to expectations, there has been no alteration in the controlled prices of the Steelmakers' Association, and joists and sections, for delivery in this area, are still quoted at £7 2s. 6d., with ship and tank plates at £7 17s. 6d. and steel bars at £8 to £8 5s. per ton. As a matter of fact, however, the price position means very little at the present time, for, except stocks in the hands of merchants, there is very little steel available. A local firm of constructional engineers started recently upon the execution of a large contract, and is now confronted with the formidable difficulty of securing supplies of British steel which is specified. Galvanised sheets are offered at £15 10s. to £15 15s. per ton f.o.b. for the usual Bombay and Calcutta specifications, but there is not much inquiry at the moment. For thin gauge sheets for the Far Eastern markets quotations were reduced last week by £1 a ton. Sellers of continental materials have further reduced their prices, and the position is still very weak. There is very little demand, and it is believed that concessions on current rates could be obtained if important business were at stake. Ordinary steel plates are about £6 3s. per ton, delivered Manchester or equal, for net cash against shipping documents; Siemens' plates, £6 10s.; bars, £5 17s. 6d. to £6; joists, £5 12s. 6d; sections, £6 to £6 2s. 6d.; and Belgian iron, £6 to £6 2s. 6d.

Scrap.

For non-ferrous metal scrap the demand is virtually dead at the moment. Cast aluminium is on offer at about £85, selected heavy yellow brass at £45, brass rod turnings at £39; lead, £28; zinc, £24; heavy copper scrap, £59; clean light copper, £57; braziery copper, £48; and best selected gun-metal, £52. Iron and steel scrap is very quiet and nominal at £2 12s. 6d. per ton for mild steel, £3 10s. for textile machinery scrap, £3 5s. for ordinary

machinery cast iron scrap, and £3 5s. for wrought iron scrap, on trucks Manchester.

BARROW-IN-FURNESS.

Waiting.

The iron and steel trade in the North-Western district is simply marking time until there is a settlement in the coal trade. A little business is being done, however, ordinary mixed numbers being sold from stock, while a small cargo or two of pig iron has been shipped to the Continent. The hoop and small section mills at Barrow are engaged, and will continue to work, as they have work to keep them going. These mills derive their power from the Barrow Corporation supply, which, by the way, is now supplying all the power to the Barrow Paper Pulp Works. In the shipbuilding and engineering trades business is continuing as usual, and several fast cross-Channel steamers of the Isle of Man Steam Packet Company are receiving their finishing touches prior to going on to the several services. This company was forced to withdraw some of the steamers advertised to sail at Whitsuntide owing to the coal restrictions; in fact, the only two large steamers running were from Liverpool, and both were fitted with oil-burning installations some time ago by Vickers—the Manxman and the Manx Maid.

SHEFFIELD.

(From our own Correspondent.)

Idle Furnaces.

THE holidays have accentuated the slackness caused by the coal strike, and few departments of local trade have worked during more than half the present week. On the heavy steel-melting side the position has been much worse, and has been practically one of stagnation. More than thirty big open-hearth furnaces in the district have been idle since the beginning of the general strike and they cannot resume work until coal supplies are again available. On the manufacturing side work has been continued to a fair extent, but some departments have had to cease operations owing to want of coal, coke and raw steel, and also because of the inadequacy of railway transport. The last-named difficulty is interfering with the execution of overseas business. In the opinion of large steel makers the strike has checked a distinct upward movement in trade. The first quarter of the year was one of steady expansion, and prospects continued bright. Even at present there are not only many inquiries afoot, but a good number of orders are being put through. At the same time, there is some falling off in foreign competition.

The Finished Trades.

Less activity is reported in the departments producing railway axles, tires and springs, as new orders have been rather scarce during the past month. The *Journal* of the Sheffield Chamber of Commerce considers, however, that better trade is pending, and that good contracts from India and the Near East are within reach. There has also been a falling off in the demand for files and various classes of tools, many consumers having suspended orders until normal conditions are restored. A good opening for the trade in files is afforded by the railways of Roumania, which are at present asking for tenders for many thousands of these tools. It is confidently anticipated that the business will be placed in Sheffield. Trade with France in tools and special quality steels, which was already on a small scale, has been almost destroyed by the rapid fall in the value of the franc. Very little business is being done by dealers in alloys of special steels.

Armament Losses Balanced.

Some interesting views on the outlook for Sheffield trade, and the way in which the city has faced post-war difficulties, are contained in the official journal of the Sheffield Chamber of Commerce for this month. "It is frequently reported," says the *Journal*, "that the only two really active lines in the British iron and steel trades are galvanised sheets and tin-plates. But what is the fact? This area makes neither of those commodities, and yet this district, almost alone among British steel areas, is producing more than in record pre-war days. The explanation is that by our local enterprise, by our price sacrifices, and by our economies, and the superior quality of our steel, we have more than balanced our great loss in armaments steel, and while the total aggregate of national demands for British steel has declined, Sheffield steel makers have secured increased trade. But for the labour dislocation the general outlook would be fairly good. Sheffield is sure to share in the coming increase of activity in steel house building. Opposition to the new type is being gradually broken. We note that one shipbuilding firm has started erecting steel houses, the entire work being done by shipyard labour under naval architect supervision. The material used is plate steel, on the double-shell principle, for both walls and roofs, with felt packing between the plates. This enterprise opens out a new avenue for Sheffield rolling mill products."

Park Gate Report.

The directors of the Park Gate Iron and Steel Company, Ltd., in their report for the year ended March 31st, state that there was no improvement in the steel trade during the period. On the contrary, competition was more intense than ever, owing to the excess productive capacity of the country in comparison with the demand for steel, and prices have fallen considerably in consequence. In these circumstances, the directors consider it satisfactory that the works have been fairly well employed all through the year, and that a profit of £51,026 has been made. This profit, which is a trifle more than last year's, will be applied to the reduction of the debit balance caused by the heavy loss of a few years ago. The amount of loss to be carried forward is £66,295.

Cutlery and Plate.

The cutlery and plate trades show no improvement, generally speaking, while for the time being they have suffered severely owing to the strike. Many orders for goods were at once suspended or cancelled, while the shipping of overseas consignments was stopped, and deliveries by parcels post were also brought to a standstill. There was a lot of short-time working before Whitsuntide, and this week has been in many cases one of full holiday. A number of small makers complain of difficulties caused by delay in payment of accounts. Contracts for hotel, restaurant and shipping equipment provide a good proportion of the trade on hand. Distribution through the ordinary shopkeeping channels is still on a reduced scale. The Dominions continue to be good customers for large quantities of goods, but their tendency to buy the cheaper qualities is still as marked as ever, and, so far as stainless cutlery is concerned, is growing. A notable event in the cutlery trade during the past week has been the retirement of Mr. F. J. Pullan, joint managing director of Joseph Rodgers and Sons, Ltd. Mr. Pullan has been with the firm forty years, starting as a clerk in the foreign office. He subsequently became general manager and secretary, and was elected to a seat on the board four years ago. The directors have appointed, as the new general manager of the company, Mr. D. A. Palmer, lately managing director of Fuller's United Electrical Works, Ltd., of Chadwell Heath, London. Mr. Palmer holds an engineering degree of the University of Birmingham.

The Best Blast-furnace Cokes.

A research in connection with blast-furnace coke, which was recently started in the Metallurgical and Fuel Departments of Sheffield University, is now to undergo a considerable extension. The research has hitherto been carried on with a view to identifying the best varieties of coke for blast-furnace purposes, but its extended scope will include the production of cokes especially suitable for blast-furnace work, and will involve large-scale investigation into the coking of coal. The research was established under the auspices of a committee representing the Midland Ironmasters' Association, the Lincolnshire Ironmasters' Association, and the Northamptonshire Blast-furnace Owners' Association. Members of the South Yorkshire Coal Trade Association and the Coke Oven Managers' Association have now been added. Two of the former are Messrs. J. H. W. Laverick, of the Tinsley Park Colliery Company, and G. T. Purves, of Rothervale Collieries, and, on behalf of their companies, these gentlemen have promised that the coke oven plants at Tinsley Park and Rothervale shall be placed at the disposal of the committee for research work.

A New Inland Waterway.

Nottingham will soon become a port accessible by 120-ton barges from the sea at Hull, thanks to the scheme of rendering the river Trent navigable, which has been carried out by the Nottingham Corporation. The scheme includes the construction of four locks and its progress has been reported in these letters from time to time. The last lock, at Hazleford, has now been completed, and will be opened on June 25th, by Mr. Neville Chamberlain, Minister of Health, who will cruise down the Trent from Nottingham for the purpose. When the channel of the river has been dredged, barges will be able to proceed from Hull to Nottingham without transhipment of goods. The size of each of the locks is sufficient to allow three 120-ton barges and a tug to be passed through at one operation. The cost of the scheme, up to date, is little short of half a million sterling, and its advantages, not only to Nottingham, but also to the towns of Newark and Grantham, and to the agricultural district through which the river passes, will be very great.

NORTH OF ENGLAND.

(From our own Correspondent.)

Industry Completely Paralysed.

THE fresh deadlock in the negotiations between the coalowners and the miners has created the gravest apprehensions in industrial circles in the North of England. For many reasons iron and steel manufacturers in particular have cause keenly to regret the present trouble, for it has put a stop to what appeared to be a steady and genuine revival which promised to continue throughout the year. Now the situation could not well be worse, the effects of the labour upheaval being acute. Not only are all the works closed down, but business in almost every department is in a state of paralysis. While some attempt has been made to carry on in other iron-producing areas since the general strike, no such step has been possible in the North of England, and even the steel works remain idle. The decision of the miners' conference not to recommend the men to accept a reduction in wages seems to indicate that there is going to be a hard struggle over the economic issue, and a general opinion prevails in commercial circles in the North of England that until the gap between proceeds and costs is bridged, there can be ltitle chance of putting the coal industry on its feet again.

Miners' Funds Almost Exhausted.

Already there is considerable distress among the mining communities of Durham and Northumberland. Ever since the last coal stoppage, five years ago, there have been thousands of miners idle in the Durham coalfield, and distress has prevailed in many districts, but in the present crisis, when there are 150,000 men and boys idle, and the funds of the Durham Miners' Association are practically exhausted, the outlook is most depressing. The Association has paid out in unemployment allowance considerably over two million pounds in the last two or three years. Since the beginning of the present dispute it has not been able to pay anything to the members, but it is proposed to pay this week-end 10s. to each man and 5s. to each youth. The funds of the Association have been continually at a low ebb because of the calls of those members who have been thrown out of work at collieries which were losing heavily on production. At one time there were 40,000 miners on the books in receipt of unemployment benefit. The miners are thus faced with hard times. Meanwhile colossal sums are being disbursed by the Guardians in the form of out-relief, and in many areas children are being fed at schools out of county funds.

Suggested Reopening of Warrant Stores.

A suggestion for the revival of the pig iron warrant stores is exciting a little interest in the Cleveland pig iron trade. In pre-war days large stocks, sometimes approaching a million tons, were held in the Public Stores at Middlesbrough, and they served as a useful reserve for any sudden trade demand. In a circular on the subject Messrs. Jacks and Company, of Middlesbrough and Glasgow, give many reasons in support of the reopening of the warrant stores. To increase the manufacture of pig iron on a large scale at present would, they point out, greatly reduce the overhead cost of the present small output, and the possible loss on the maximum quantity that has ever been in the store would be infinitesimal compared with the present unemployment expenditure. Nothing would benefit labour more. In ironstone mining, limestone mining, in coal, in coke, at the blast-furnaces, &c., the percentage amount expended on labour is enormous, and thus relief would commence at once. The ironmasters, add Messrs. Jacks, may dread the effects of iron in public stores, but so far as they are concerned the benefits equal the disadvantages, and as the general public uses a large proportion per head of iron and steel in various forms, it is entitled to demand that its requirements should be supplied at the lowest possible price, and that everything should be done that can be done to bring that condition about. Steps would naturally have to be taken to safeguard the public against any possible exploitations of the scheme for the purpose of increasing the price to the consumer. The cost, therefore, of limestone, ore, coke, and pig iron and the respective wages of workmen employed in the various processes, would all be fixed at or about the present basis, and the moment that any of these constituent factors arose unduly the scheme would automatically stop.

Iron and Steel Market.

The Cleveland iron and steel market presents a lifeless state. There is little disposition to do business in present circumstances. Apart from the uncertainties regarding deliveries, Cleveland prices are too high for the foreigner to pay, and home consumers are taking only very small parcels indeed. Still, the makers are adhering to the half-crown advance, and are now quoting for home business as follows:—No. 1 Cleveland foundry iron, 76s.; No. 3 G.M.B., 72s. 6d.; No. 4 foundry, 71s. 6d.; No. 4 forge, 71s. The extra 6d. per ton is still asked for export orders. East Coast hematite mixed numbers are offered at 77s. per ton, and No. 1 quality at 77s. 6d., but there is very little demand indeed. Steel makers are able to meet orders from stock, but in some cases a few shillings extra have been paid, although minimum quotations are unchanged.

The Coal Trade.

The failure to come to any agreement with the miners was very disappointing to operators in the Northern coal trade. With no coal or coke available for export immediately, and coalowners declining to quote ahead, negotiations and sales are entirely suspended. Even speculators refuse to entertain any proposals. Prices after the resumption will be a problem, and, in view of the low level prevailing on the Continent, they will have to be cut to secure any business.

SCOTLAND.

(From our own Correspondent.)

The General Position.

So far as actual business is concerned, there has been no real improvement since the collapse of the general strike, and no progress is probable until the coal trade is again at peace. Many large concerns which closed down during the general strike have not restarted and others will be forced to close down owing to a lack of fuel if the coal strike lasts much longer. Essential services are well maintained, but otherwise the situation is one of inactivity.

Steel and Iron.

A large number of the steel and iron works have not restarted. The former are affected by a lack of fuel, while the latter are hindered by the difficulty in reaching an agreement between employers and men with regard to future action, the former demanding a guarantee against a repetition of the general strike action. A restart has been made at the Clydesdale Steel Works, Mossend—Stewarts and Lloyds, Ltd.—as the firm has fuel enough to cover several weeks' requirements. A firm of sheet-makers in Wishaw was able to carry on all through the strike period. The stoppage at the steel works is severely felt in the shipyards, owing to the inevitable scarcity of steel material.

Pig Iron.

The restart in the pig iron industry is confined to some eleven or twelve furnaces, compared with round about twenty in operation before the strike. The remainder have either been blown out or damped down.

New Contracts.

It is announced that the Clyde Crane and Engineering Company, Motherwell, has received an order on behalf of the South African Railways for the erection of level luffing harbour cranes. This contract is the largest

for this particular type of crane placed in this country for some time. Scott's Shipbuilding and Engineering Company, Greenock, is to build a small single-screw steamer for the Straits Steamship Company. Two vessels of 8500 tons each, in addition to the couple ordered shortly after the new year, are being built by the same company for London owners.

Coal.

It has been reported that three steamers of moderate carrying capacity have arrived light at Burntisland, and that arrangements have been completed for loading their respective cargoes. Two squads of trimmers are engaged. It is understood that these cargoes are to be utilised in bunkering fishing vessels and also to augment stocks at certain English gasworks. There is, of course, no change in the coal market, business being practically impossible under present conditions. Household fuel is very scarce, many depôts being entirely cleared of supplies. Owing to transport difficulties, it is questionable if even "ration" supplies will be available. Municipal services are maintained, but railway and steamer facilities, especially the latter, are being cut down.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Dispute Deadlock.

THE complete breakdown in the negotiations for a settlement of the coal dispute has naturally induced a pessimistic feeling in this district. The view is held that, unless there are unexpected developments very quickly, no resumption of work will be seen before the middle of June, and in some quarters it is feared that it may be July before a restart can be arranged. As to how a settlement is to be brought about, seeing that the miners' leaders still adhere to their determination that there shall be no reduction in wages or extension of working hours, it is difficult to say, though the general opinion is that a ballot of the workmen, more especially on the hours question, would probably prove to be the solution. Meantime, of course, the coal export trade is at a standstill, and the longer the duration of the stoppage the greater will be the damage to the foreign markets for Welsh coal. Exporters here are being inundated with offers of American, German, Belgian and French coals, and so far at least half a dozen cargoes of American coals have been arranged for delivery at United Kingdom ports, presumably for gas undertakings and railway purposes. American coals on the basis of 60 per cent. large suitable for locomotive purposes are being offered at about 7·40 to 7·50 dollars c.i.f. British ports, but, as invariably happens, both the Americans and Germans are doing their utmost to get into all markets by offering extended credit and to fix up long-period contracts. There is no doubt that already a considerable amount of business has gone to foreign coalfields which, under normal circumstances, would have been placed in this country, and that means that if a settlement of our troubles were to come at once the demand from abroad would be very restricted for a few weeks. Many foreign consumers have been delaying purchasing American and German coals in the belief that the stoppage of work in this country would by now have come to an end, but the present deadlock in the negotiations will in all probability induce them now definitely to look elsewhere than this country for their requirements.

Strike Aftermath.

As indicated last week the strike of workmen at Swansea Docks came to an end. The decision was arrived at on Thursday, and was rather foreshadowed by the action of many workmen dribbling back on their own account. The men got tired of the protracted negotiations, and ultimately the terms insisted on by the Great Western Railway Company and the Swansea Port Employers' Association were accepted. A good deal of work had previously been diverted from Swansea, and the decision to resume work was only arrived at just in time to prevent other important work going elsewhere. As much as 20,000 tons of zinc concentrates were either in the port or due from Australia, and those cargoes would have gone to another port for discharge if an early resumption of work at Swansea had not been decided upon. One steamer, the s.s. Papanni, with 8000 tons, had arrived within the previous twenty-four hours, and another boat was due within a few days, while a third steamer is expected to arrive about the end of this month. Before the end of last week the dispute, so far as Port Talbot was concerned, was brought to an end, and the Cardiff tugboatmen also declared their strike off, and accepted the terms of the tugboat owners, who proposed to put into commission four out of twenty-eight boats to work the ports of Cardiff, Penarth and Barry. There has been a slight improvement in ship-repairing in this district, but it is regarded only as temporary. It is very well known that quite a number of orders have gone to Rotterdam and other continental ports, several of them running into thousands of pounds each, while the postponement of a settlement of the coal dispute will determine shipowners to keep their boats away from this country longer. Work at the steel and iron and many of the tin-plate works is on a considerably reduced scale owing to the shortage of coal. At the Ebbw Vale sheet mills there is still trouble owing to the dismissal of a workman for not doing work allotted him by the management, and the other men, numbering between 400 and 500, have declined to return until he is reinstated. These men are connected with the Iron and Steel Trades Federation.

Industrial Items.

It is understood that the owners of the Copper Pit Colliery, Morriston, have informed their workmen who are now out that they must remove their tools this week, as the colliery is to be closed down indefinitely. Work was resumed on Tuesday at the finishing department at Cwmfelin Tin-plate Works, Swansea, but it is expected that shortage of coal will prevent operations for any length of time. The Ashburnham Tin-plate Works, Burry Port, which have been at a standstill for several weeks, have also restarted. These works have been completely brought up to date, and will employ upwards of 250 men.

Coal Position.

Extremely strict control is being maintained over the stocks of coal available in this district. In one or two cases vessels have been allowed to complete their cargoes, but bunkers are practically unobtainable. Owners of some small vessels engaged in carrying flour and other commodities to home coasting ports have bought supplies of pitwood to use as bunkers, while fishing trawlers in some instances have gone to near continental ports in order to obtain bunker coal. There is, of course, no coal market, while pitwood is a weak section at about 20s. to 21s. ex ship.

The Institution of Civil Engineers.

APRIL EXAMINATIONS, 1926.

PASS LIST (*INTERIM.*)

(Subject to confirmation by the Council.)

Preliminary (99).—(*The results of the examination held abroad will be announced later.*)—A. A. A. Abdeldayem, W. G. McD. Anderson, H. G. Andrews, A. L. Archibald, J. Arrol, F. R. L. Barnwell, G. Blackwood, D. Blenkinsop, H. R. Bridger, J. B. R. Brooke, C. V. Brown, H. B. Buckingham, G. C. Bunn, D. M. Cameron, C. W. Cassé, A. W. Chapman, W. C. Clarke, J. V. Cook, S. M. Davies, W. P. J. Davison, H. E. Dohoo, H. J. Donovan, G. L. A. Downing, L. A. Drain, A. H. Draz, H. J. Eddie, G. C. N. Elliott, R. B. Francis, A. H. Freeman, W. A. Fuller, L. J. Goldsmith, E. F. Goodwin, R. T. Goymer, R. H. Greaves, S. A. Green, D. W. Harvey, J. E. Johnson, J. A. Johnston, A. H. Kennard, T. C. Ketchen, N. Lampitt, E. J. Land, J. R. Langridge, A. C. L. Law, W. B. Lawson, C. F. V. Lawton, C. R. A. Linton, H. D. S Lowe, D. McBride, W. McConnachie, J. B. McGaw, D. McVean, C. A. Massie, J. W. Mills, D. Mitchell, J. Motion, R. C. Mumby, H. Newton, W. F. Nicholas, A. J. P. Pashler, J. G. Paterson, R. N. Pegg, J. R. Pilkington, R. J. Pugh, D. H. Ramage, E. Roberts, G. W. Roberts, R. G. S. Roberts, D. Robertson, W. T. Rondel, E. L. Rushbrooke, J. C. Russell, E. E. Samuel, J. D. Sharman, J. S. Silver, J. N. Smith, L. E. Snell, J. A. Sturrock, M. W. Summers, G. N. Swayne, K. C. M. Symons, R. E. Taylor, T. S. Taylor, jun., W. Tivendale, R. F. Tucker, H. P. Turner, W. A. Turner, J. P. Walton, T. D. Watson, H. J. Welch, G. M. Wheat, V. C. Whiting, A. Wilkinson, R. J. Williams, I. H. Wilson, F. Wood, H. W. Wood, D. F. Young, W. Young.

ASSOCIATE MEMBERSHIP (243).

Whole Examination (Sections A, B, and C) (14).—J. L. Beckett, H. Erskine, G. A. Green, H. Halstead, B. F. Holden, H. T. Hough, H. W. Jarvis, M. G. Maycock, E. B. Nisbet, A. K. Pollock, A. B. Porter, K. Scott, T. S. Sinclair, H. Turner.

Sections A and B only (26).—H. S. Andrew, A. N. Burgess, T. F. Burns, J. L. Chapman, J. W. Clark, H. E. T. Compton, A. Cowie, E. Edwards, T. E. Emmett, T. L. Gray, F. F. Horton, J. S. Ireland, R. H. James, J. MacF. MacAlpine, P. M. B. McBain, C. H. McDowell, E. A. Middle, R. J. Nichols, J. Russell, A. C. W. Ryland, R. W. C. Smith, F. R. Speight, D. E. Strachan, F. V. Wickham, T. U. Wilson, K. F. W. Woods.

Sections B and C only (12).—H. A. Anderson, jun., W. S. Catlow, H. K. Cox, H. D. Drummond, G. H. Fretwell, R. W. Hall, H. Haughton, G. Holbourn, R. Mackrill, J. Oldfield, B. Whitteron, A. C. Wilson.

Section A only (57).—F. W. Adie, E. Adlington, E. B. Allinson, J. Baker, N. C. C. Barrell, R. Bates, E. E. Box, C. W. E. Brown, A. C. Burnett, W. H. Burren, L. Carnie, F. H. Coleby, R. Cornish, H. Davies, J. A. L. Denison, J. P. Dockray, A. A. Doig, D. C. Doig, W. A. Doig, H. M. Everett, K. Fraser, C. B. Genke, E. H. Hargrave, M. A. Hasan, C. A. Hayes, N. B. Henderson, R. S. B. Hervey, D. Hide, D. Holdsworth, E. L. Horn, D. J. Howe, J. R. Howe, E. Hoyte, A. R. Jefferson, G. R. Kettlewell, J. McE. King, G. C. Law, J. D. Malcolm, H. Milne, A. Mitchell, F. Morgan, H. F. Noyce, W. T. P. Perkins, G. M. Pickard, A. K. Richards, J. MacM. Riddet, J. G. Shakespeare, F. A. Shorter, I. M. Simmie, G. Slater, J. H. Todd, S. L. Vincent, H. N. Wilford, J. E. Wilson, J. E. Wilson, D. B. Wood, N. Worrall.

Section B only (38).—W. J. Allen, R. A. T. Anderson, R. H. Austin, J. Blackburn, R. Blakeborough, G. H. H. Collins, A. B. Cooper, P. G. Corder, R. H. Cunningham, J. F. Darnbrough, T. S. B. Dick, H. C. E. Dunn, F. Eaves, C. B. Eck, W. S. Evans, W. E. Fecher, E. Gill, J. H. Humphreys, E. Hutton, W. B. Instone, N. V. Jeffery, N. Jervis, G. F. Kent, E. L. Key, H. V. Langley, J. E. Lewis, W. B. Macfarlane, J. A. McManus, L. F. Nicholson, M. W. G. Overton, A. L. Owen, G. Perry, G. A. Phillips, D. D. Thorp, G. W. Warr, L. C. Whiskin, T. Willey, H. Wolf.

Section C only (96).—E. K. Adam, B.Sc. (Glas.), H. C. Adams, M.C., B.A. (Cantab.), C. G. Alderton, C. F. Armstrong, B.Sc. (Edin.), H. Atkinson, H. Bailey, W. R. Bailey, B.Eng. (L'pool), S. R. Banks, B.Eng. (L'pool), L. P. Bard, B.Sc. Eng. (Lond.), R. Barrett, B.A. (Cantab.), J. F. Bickerton, B.Eng. (L'pool), A. A. Birch, B.Sc. (Leeds), E. K. Bridge, B.Sc. (Glas.), W. J. N. Bryce, B.Sc. (Glas.), A. H. Cantrell, B.Sc. Eng. (Lond.), A. B. Catling, C. J. Chaplin, B.Sc. Eng. (Lond.), H. Clayton, H. F. Cloke, B.Sc. Eng. (Lond.), C. B. H. Colquhoun, B.Sc. Eng. (Lond.), G. J. L. Cowdell, B.A. (Cantab.), H. F. Cronin, M.C., B.Sc. Eng. (Lond.), A. V. H. Crummack, F. H. Davies, B.Sc. Eng. (Lond.), A. L. Dent, B.Sc. Eng. (Lond.), N. G. Elliot, B.Sc. (Leeds), L. B. Escritt, G. R. Fenton, H. W. Flett, A. Floyd, B.Sc. (Durham), J. A. Formunt, B.Sc. Eng. (Lond.), I. S. Fraser, B.Sc. (Glas.), W. E. Gelson, B.Sc. Eng. (Lond.), H. H. George, B.E. (Sydney), S. K. Gilbert, F. I. S. Gill, J. H. Glendinning, B.Sc. (Belfast), F. W. Goodman, E. R. Green, J. E. Gregory, F. R. Hall, B.Sc. Eng. (Lond.), A. M. Hamilton, B.E. (New Zealand), J. B. F. Hawkins, C. E. M. Herft, G. F. Holdsworth, J. M. M. Howat, J. Y. Hughes, C. R. Hutchinson, B.Sc. (Leeds), F. R. Keene, D. H. Lee, B.Sc. Eng. (Lond.), F. C. L. Lloyd, H. Lloyd-Williams, B.Sc. (Glas.), A. G. McDonald, B.Sc. Eng. (Lond.), I. M. Mackay, B.Sc. (Edin.), J. MacNiven, A. G. Mansell, W. E. Marsh, G. G. Marsland, S. Mehew, B.Sc. Eng. (Lond.), J. E. W. Monkhouse, G. Morgan, B.Sc. (Wales), J. P. Musgrave, B.A. (Cantab.), H. Neal, R. M. Owen, B.A. (Cantab.), J. W. Pallister, C. C. Parkman, J. P. Paton, B.Sc. (Edin.), T. Perkins, B.Sc. Eng. (Lond.), F. J. N. Polkinhorne, B.Sc. Eng. (Lond.), C. R. Porter, T. Porter, S. G. Ronan, B.A., B.A.I. (Dublin), A. Ross, B.Sc. Eng. (Lond.), J. R. Russell, B.Sc. (Edin.), G. G. E. Scribante, F. C. Simmons, B.Sc. (Bristol), A. J. Small, C. R. Smith, B.Sc. (Manchester), J. F. Summersgill, C. K. Thompson, B.Sc. Eng. (Lond.), C. A. M. Thornton, B.A. (Cantab.), F. W. D. Timson, R. V. Trace, C. B. Trye, B. E. A. Vigers, B.A. (Cantab.), F. W. Waddell, C. G. B. Wale, B. E. B. Walker, A. J. B. Wardle, B.Sc. (Birmingham), J. Watt, R. W. Weekes, H. C. Weston, B.Sc. (Glas.), S. White, B.Sc. (Durham), L. G. Wills, B.Sc. Eng. (Lond.), A. Young, B.Sc. (Glas.), W. V. Zinn, B.Sc. Eng. (Lond.).

Catalogues.

THOMAS BROADBENT AND SONS, Ltd., Huddersfield.—Brochure illustrating and describing the "Broadbent" patent automatic centrifugal clutch.

F. GILMAN (B.S.T.), Ltd., Grange-road, Smethwick, Birmingham.—Catalogue of boiler and ship scaling tools and rust removing apparatus.

POWER GAS ECONOMY COMPANY, 50, Wellington-street, Glasgow.—Brochure containing particulars of the Hunter gas regulator and gas burners.

THE MENNO COMPRESSED AIR GREASECUP COMPANY, Ltd., Leeds-place, N. 4.—Booklet describing the "Menno" method of applying grease to bearings.

F. A. WILKINSON AND PARTNERS, Ltd., Gretton, near Kettering.—Leaflet describing the "Auto-Ignitor" ignition system for internal combustion engines.

CRANE PACKING, Ltd., Slough, Bucks.—Booklet entitled "Metallic Packing," containing much information with regard to packing service and stuffing-box design.

THE DARLINGTON FENCING COMPANY, Ltd., 5, Lloyd's-avenue, E.C. 3.—Book entitled "Ware Wire," introducing a fencing wire which is galvanised after being woven.

THE ENGLISH ELECTRIC COMPANY, Ltd., Queen's House, Kingsway, W.C. 2.—Publication No. 364A, entitled "English Electric Asynchronous-Synchronous Motors."

RONALD TRIST AND CO., Ltd., 56, Victoria-street, S.W. 1.—Catalogue describing the working of the "Thermofeed" regulator and the advantages obtained therefrom.

THE BRITISH RESISTOR COMPANY, Ltd., 32, Clare-road, Halifax.—Booklet entitled "The Story of the 'Globar,'" describing the non-metallic heating element "Globar."

FERRANTI LIMITED, Hollinwood, Lancs.—Pamphlet describing a 450,000 volts testing equipment for cable factory.—Also Pamphlet Te 151 dealing with oil-immersed transformers.

THE POWER SPECIALITY COMPANY, Ltd., Aldwych House, Aldwych, W.C. 2.—Two catalogues, one describing the Foster economiser, the second the Foster radiant heat superheater.

DAVID BROWN AND SONS (Huddersfield), Ltd., Huddersfield.—Treatise entitled "Automobile Worm Gearing," dealing with the design, use and application of worm gearing to automobiles.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., Trafford Park, Manchester.—Publication No. 7747/6 on electric winders and D.L. 750/1-1 describing the Metropolitan-Vickers coal cutter protection system.

INTERNATIONAL COMBUSTION, Ltd., 11, Southampton-row, W.C. 1.—Catalogue H. 600 illustrating and describing the Hardinge conical ball and pebble mills for the grinding of ores and industrial products.

THE CONSOLIDATED PNEUMATIC TOOL COMPANY, Ltd., 170, Piccadilly, W. 1.—Booklet describing C.P. arc welding plants.—Also Pamphlet No. 322 relating to a new type of governor controlled self-lowering jack.

DEMAG, DEUTSCHE MASCHINENFABRIK A.G., Düsseldorf, Germany.—Illustrated volume of 540 pages dealing with the crane and machinery equipment of shipyards, workshops, covered slipways, fitting-out quays and docks.

EDUCATIONAL INTELLIGENCE.

A COURSE of four advanced lectures on "Tubbing Deep Shafts" and "Subsidence" will be given in the Mining Department of the Imperial College, Royal School of Mines, Prince Consort-road, South Kensington, S.W. 7, by Professor L. Denoël, Professor of Mining in the University of Liège, at 5.15 p.m. on May 31st, June 1st, 2nd, and 3rd, 1926. The lectures, which will be delivered in English and illustrated with lantern slides, are addressed to students of the University and to others interested in the subject. Admission free, without ticket.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. W. J. LIBERTY, Public Lighting Superintendent for the City of London, resigned his office last month, under the Corporation pension scheme, after forty-seven years of service, he having reached the retiring age.

INTERNATIONAL OIL EXHIBITION FOR LONDON.—The management of the Crystal Palace announces that the International Oil Exhibition, which was originally intended to be held this year, has now been fixed for May, 1927. The opening date will be May 4th, and the Exhibition will be open for seventeen days. It is to be strictly limited to companies and firms directly associated with the production, refining, transport, and distribution of petroleum products, and will be under the patronage of the Institution of Petroleum Technologists, the Oil Industries Club, &c. Over 100,000 square feet of exhibit space will be available on the main floor of the Crystal Palace, and it is anticipated that the Exhibition will be the largest and most comprehensive oil trade show yet organised.

THE NEWCOMEN SOCIETY SUMMER MEETING, 1926.—As already announced, the summer meeting of the Newcomen Society for the Study of the History of Engineering and Technology is arranged to take place in the Norwich district, and details of the programme are given below. Wednesday, June 23rd, 8.30 p.m., Royal Hotel. Paper by Mr. H. O. Clark, member, with lantern illustrations, "Ancient Local Industries." Thursday, June 24th, 9 a.m., official welcome at the Guildhall by the Lord Mayor (Mr. Thomas Glover, M. Inst. C.E.) and members of the Corporation. The regalia and Corporation plate will be on view. 9.30 a.m., motor omnibus leaves Guildhall. 10.15 a.m., arrive Stokesby. Visit windmill with scoop wheel, by permission of Mr. R. Waters. 11.30 a.m., arrive West Somerton. Visit pumping station, by kind permission of the Winterton and Somerton Drainage Commission; grasshopper engines, windmill and turbine pumps. 1.15 p.m., arrive Lound *vid* Yarmouth. Visit pumping station, Lowestoft Water and Gas Company, by permission of Mr. J. Hawksley, manager; grasshopper and other engines. Visit tower windmill, by permission of Lord Somerleyton. 3 p.m., arrive Lowestoft. Visit, by permission of the London and North-Eastern Railway, Dredger No. 1; grasshopper engines. Dredger No. 2, side lever engines. 7.30 p.m., Royal Hotel. Society's dinner. 8.30 p.m., Royal Hotel. Paper by Mr. Walter R. Rudd, with lantern illustrations, "The Strangers in Norwich: A Page in the History of Our Ancient Textile Industry." Friday, June 25th, 9.10 a.m., visit silk weaving works (hand looms) of Messrs. James Arnold and Co. 10.30 a.m., visit Harrison's post windmill, Sprowston-road. 11.30 a.m., visit Bridewell Museum. The Curator, Mr. Frank Leney, will personally conduct the party. 2 p.m., meet at the Deanery. Visit to Norwich Cathedral, personally conducted by the Very Reverend J. W. Willink, D.D., Dean of Norwich.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	18/- to 21/-
(1) Spanish	18/- to 21/-
(1) N. African	18/- to 21/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	21/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 17 0	—
No. 1 Foundry	3 19 0 to 4 1 6	
No. 3 Foundry	3 16 6 to 3 19 0	
N.E. COAST—		
Hematite Mixed Nos.	3 17 0	3 17 0
No. 1	3 17 6	3 17 6
Cleveland—		
No. 1	3 16 0	3 16 6
Silicious Iron	3 16 0	3 16 6
No. 3 G.M.B.	3 12 6	3 12 6
No. 4 Foundry	3 11 6	3 12 0
No. 4 Forge	3 10 6	3 11 0
Mottled	3 10 0	3 10 6
White	3 10 0	3 10 6
MIDLANDS—		
(5) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 4 0 to 3 5 6	
,, Forge	2 16 0	—
(3) Derbyshire—		
No. 3 Foundry	3 7 6 to 3 9 0	
Forge	3 2 0	—
(3) Lincolnshire—		
No. 3 Foundry	3 8 0	—
No. 4 Forge	3 5 6	—
Basic	3 6 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 7 6 (a); 4 10 0 (b); 4 15 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	11 5 0	11 0 0
Best	—	—
N.E. COAST—		
Common Bars	11 0 0	—
LANCS.—		
Crown Bars	11 0 0	—
Second Quality Bars	9 15 0	—
Hoops	14 0 0	—
S. YORKS.—		
Crown Bars	12 10 0	—
Best Bars	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—		
Crown Bars	11 0 0 to 11 10 0	
Marked Bars (Staffs.)	14 0 0	—
Nut and Bolt Bars	10 5 0 to 10 10 0	
Gas Tube Strip	12 5 0 to 12 10 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	11 0 0	—
Ship Plates, ¾in. and up	7 12 6	7 0 0
Sections	7 2 6	6 5 0
Steel Sheets, under 3/16in. to ¼in.	8 15 0 to 9 5 0	
Sheets (Gal. Cor. 24 B.G.)	—	£15 7 6 to £16 10s.

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	7 12 6	—
Angles	7 2 6	—
Boiler Plates	11 10 0	—
Joists	7 2 6	—
Heavy Rails	8 0 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 0 0†	—
Light Rails	8 5 0 to 8 10 0	
Billets	7 10 0 to 9 0 0†	
MANCHESTER—		
Bars (Round)	8 0 0 to 8 5 0	
,, (others)	8 0 0 to 8 5 0	
Hoops (Best)	13 5 0	13 0 0
,, (Soft Steel)	10 0 0	9 15 0
Plates	7 17 6	—
,, (Lancs. Boiler)	11 10 0	—
SHEFFIELD—		
Siemens Acid Billets	10 10 0	—
Bessemer Billets	11 5 0	—
Hard Basic	8 12 6	—
Intermediate Basic	8 2 6	—
Soft Basic	6 15 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0	—
MIDLANDS—		
Small Rolled Bars	7 15 0 to 8 0 0	
Billets and Sheet Bars	6 2 6 to 6 5 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	15 10 0 to 15 15 0	
Angles	7 2 6 to 7 5 0	—
Joists	7 2 6 to 7 5 0	—
Tees	8 2 6 to 8 5 0	—
Bridge and Tank Plates	7 17 6	—
Boiler Plates	11 0 0 to 11 10 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	19/3 to 19/6
Block Tin (cash)	268 15 0
,, (three months)	265 5 0
Copper (cash)	56 10 0
,, (three months)	57 7 6
Spanish Lead (cash)	28 10 0
,, (three months)	29 0 0
Spelter (cash)	32 3 9
,, (three months)	32 12 6
MANCHESTER—	
Copper, Best Selected Ingots	61 10 0
,, Electrolytic	65 5 0
,, Strong Sheets	90 0 0
,, Tubes (Basis Price)	0 1 0½
Brass Tubes (Basis Price)	0 0 11½
,, Condenser	0 1 2
Lead, English	30 17 6
,, Foreign	29 10 0
Spelter	31 0 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/- per lb.	
Ferro Tungsten	1/9d. per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£22 10 0	7/6
,, 6 p.c. to 8 p.c. ,,	£22 0 0	7/3
,, 8 p.c. to 10 p.c. ,,	£20 15 0	6/9
,, Specially Refined		
,, Max. 2 p.c. carbon	£38 10 0	12/6
,, ,, 1 p.c. ,,	£44 10 0	15/-
,, ,, 0·70 p.c. carbon	£54 10 0	17/6
,, ,, carbon free	1/5½d. per lb.	
Metallic Chromium	3/3 per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	£11 15 0 scale 5/- per unit	
,, ,, 75 p.c.	£20 10 0 scale 6/- per unit	
,, Vanadium	14/6 per lb.	
,, Molybdenum	6/- per lb.	
,, Titanium (carbon free)	0/11 per lb.	
Nickel (per ton)	£170	
Cobalt	10/- per lb.	
Aluminium (per ton)	£112	

FUELS.

SCOTLAND.

(Prices nominal.)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	15/9
,, ,, Ell	16/6
,, ,, Splint	16/6 to 17/-
,, ,, Trebles	15/9
,, ,, Doubles	14/- to 14/6
,, ,, Singles	13/9
AYRSHIRE—	
(f.o.b. Ports)—Steam	16/9
,, ,, Jewel	17/- to 17/6
,, ,, Trebles	17/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	12/6 to 14/9
Screened Navigation	21/-
Trebles	14/- to 15/-
Doubles	14/-
Singles	13/- to 13/6
LOTHIANS	
(f.o.b. Leith)—Best Steam	14/- to 14/3
Secondary Steam	13/6
Trebles	14/6 to 14/9
Doubles	13/6
Singles	13/6

ENGLAND.

	Inland.	Export.
(8) N.W. COAST—		
Steams		23/-
Household		40/- to 48/-
Coke		24/-
NORTHUMBERLAND—		
Best Steams		16/-
Second Steams		14/6 to 15/-
Steam Smalls		8/- to 8/6
Unscreened		13/- to 13/6
Household		20/- to 22/-
DURHAM—		
Best Gas		18/6 to 19/-
Second		15/- to 15/6
Household		20/- to 22/-
Foundry Coke		18/- to 20/-
SHEFFIELD		
Best Hand-picked Branch	31/- to 34/-	—
Barnsley Best Silkstone	28/- to 30/-	—
Derbyshire Best Brights	26/- to 28/-	—
,, ,, House	24/- to 25/-	—
,, ,, Large Nuts	17/- to 20/-	—
,, ,, Small	12/6 to 14/-	—
Yorkshire Hards	17/- to 19/6	—
Derbyshire Hards	16/- to 19/-	—
Rough Slacks	10/- to 12/6	—
Nutty Slacks	7/6 to 9/-	—
Smalls	3/6 to 6/-	—
Blast-furnace Coke (Inland)*	—	—
,, ,, (Export)	f.o.b.	16/- to 17/-

(9) SOUTH WALES.

(All prices nominal.)

CARDIFF—	
Steam Coals:	
Best Smokeless Large	26/- to 27/-
Second ,, ,,	24/6 to 25/6
Best Dry Large	24/- to 25/-
Ordinary Dry Large	21/- to 22/-
Best Black Vein Large	25/6 to 26/-
Western Valley Large	24/6 to 25/-
Best Eastern Valley Large	24/- to 25/-
Ordinary ,, ,,	23 6 to 24/-
Best Steam Smalls	17/- to 18/-
Ordinary ,,	16/- to 17/-
Washed Nuts	19/- to 26/-
No. 3 Rhondda Large	26/6 to 27/-
,, ,, Smalls	18/- to 18/6
No. 2 ,, Large	24/- to 25/-
,, ,, Through	20/- to 21/-
,, ,, Smalls	15/- to 16/-
Foundry Coke (export)	40/- to 50/-
Furnace Coke (export)	25/- to 30/-
Patent Fuel	22/- to 24/-
Pitwood (ex ship)	20/- to 21/-
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	39/- to 40/-
Seconds	32/6 to 35/-
Red Vein	27/- to 29/-
Machine-made Cobbles	47/6 to 50/-
Nuts	47/6 to 50/-
Beans	42/6 to 44/-
Peas	23/- to 25/-
Breaker Duff	7/6 to 8/-
Rubbly Culm	12/6 to 13/6
Steam Coals:	
Large	22/6 to 24/6
Seconds	20/- to 22/-
Smalls	11/- to 15/-
Cargo Through	16/6 to 17/6

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayreshire. (6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 17/-, with fluctuations according to analysis; open market 17/6 to 19/- at ovens. † Latest quotations available. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

The Trade Outlook.

CONSIDERING the difficulties under which the country is labouring with abnormal monetary values, the engineering trades are in a rather better position than might have been expected, and although there is no real activity, some fair business is being done, owing mainly to the desire of buyers to give out orders in anticipation of further advances in prices. Those advances are so continual that all are anxious to cover themselves as far as possible. Another rise is inevitable as the result of the decision of coalowners in the Nord and the Pas de Calais to advance the prices of coal and coke to compensate for the higher wages paid to the men. As the Miners' Federation declares that the advance in wages must be made general in all the colliery districts, manufacturers must obviously look to a further increase in costs. Unfortunately, it has become very difficult to know what those costs are, and the situation of the manufacturer is at present an unenviable one, for he cannot be sure whether he is making a profit or not. He is therefore no longer disposed to regard the collapse of the franc as favourable to export business, and the practice is becoming more and more general to stabilise export prices by approximating more closely to the gold standard. The artificial stimulus given to business by speculative buying while the franc is falling, is much less marked than formerly, and the situation is becoming increasingly serious. The effect of this state of things is observable in the general decline of imports and exports during March, both in quantity and value.

International Steel Union.

The necessity of reorganising the iron and steel trades on the Continent with a view of insuring an equitable distribution of foreign orders and of limiting production to international requirements, has compelled French and German firms to continue negotiations for the constitution of an International Steel Union, despite the almost insuperable difficulties that appear to stand in the way of its successful formation. At present, the countries represented at the conferences are France, Germany, Belgium Luxemburg and the Saar, and it is remarked with regret that Great Britain has shown no inclination to take part in the proceedings. The recent conference in Brussels was adjourned and will be resumed in Paris, when it is hoped that something will be done to lay down the basis of a practical scheme. Meanwhile, the Lorraine steel makers have been conferring with the Germans over the question of the exportation of steel from Lorraine into Germany. This has become a vital matter for the restored province, which finds itself deprived of its principal market, and is unable to dispose of the whole of its products in France, while, on account of its geographical position, it is practically shut off from other markets. If the Germans refuse to take Lorraine steel, the situation of the industry is likely to become critical, unless the carrying out of the great inland waterway undertakings should allow of the product being conveyed to the ports for shipment at low cost. The Germans declare that the quantity of steel they are prepared to take must be dealt with during the forthcoming negotiations in Paris. The French are particularly anxious to arrive at some settlement, in order to avoid the competition of Lorraine steel at home. The position of the Germans in negotiating with the French has been obviously strengthened by the formation of the Vereinigte Stahlwerke, comprising several of the leading steel firms with an annual production of 2,500,000 tons of pig iron and 3,700,000 tons of steel. This new organisation is the most powerful of its kind in Europe.

Hydraulic Works.

The North and East African Colonies are offering a particularly wide field for the enterprise of the hydraulic engineer. Those territories are expected to supply the bulk of the country's requirements in raw material in the future, and the successful opening up of the cotton-producing and other agricultural regions depends upon a suitable distribution of water over very wide areas. Notwithstanding the limited financial resources at the moment, work is being continued in the Niger Valley for the carrying out of a vast scheme of irrigation, which is to permit of the creation of extensive cotton fields, and an interesting communication was made recently to the Academy of Science by M. Tilho upon the urgent necessity of constructing a barrage to prevent the water, which at present supplies Lake Chad, from descending to the Niger. He affirms that unless this is done there is serious danger of the lake being completely dried up and of 160,000 square miles of highly fertile territory becoming a desert. Lake Chad is supplied principally by the Lagone River, which, in the event of floods, threatens to carry away the bank and flow into the Benoué, a tributary of the Niger. The danger is increased by the construction, in 1911, of a canal between the Lagone and a tributary of the Benoué. M. Tilho suggests that the simplest way to avert the danger is to construct a barrage near the Gauthiot Falls, where the canal and the tributary joins the Benoué River. He urges that no time should be lost in sending out a technical commission to Lake Chad to see what should be done, for every year will increase the difficulty of dealing with the problem.

Electric Vehicles.

The propaganda being carried out by the Union des Syndicats de l'Electricité in favour of electric road vehicles is meeting with success. The cost of petrol is becoming so exorbitant that more attention is naturally given to electricity, which has the advantage of being supplied at night for recharging batteries at a low figure. The electrical companies would gladly make special terms for the purpose during hours when there is practically no load on their plants. The Union des Syndicats is so far satisfied with the results of previous trials that it has decided to organise another demonstration next month, particularly with the idea of proving the efficiency and economy of commercial vehicles.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

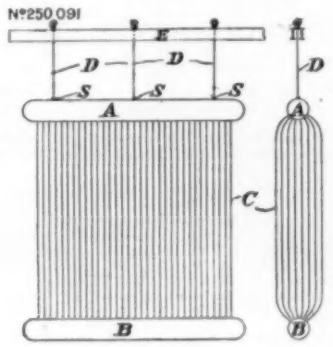
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

250,091. August 24th, 1925.—IMPROVED MEANS FOR SUPPORTING WATER-TUBE BOILERS, Lebrecht Steinmuller, of Gummersbach, Germany.

The inventor describes an improved form of suspension for any desired size of water-tube boiler and suitable for all conditions, even when the girder or similar support bends or curves under the temperature conditions which prevail. A and B are upper and lower drums respectively, connected together

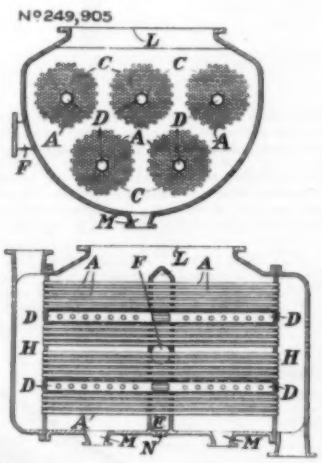


by a bank of tubes C. The complete unit is supported from a girder E by means of three flexible supporting members D. The position of the eyes S is chosen so that, as far as possible, the weight is distributed over the three points of support, and in order to ensure that each hanger takes its proper share of load, the hangers are made flexible or resilient. Several other forms of resilient suspensions are illustrated and described.—*April 9th*, 1926.

CONDENSERS AND FEED-WATER HEATERS.

249,905. December 3rd, 1924.—IMPROVEMENTS IN STEAM CONDENSERS, *Harry Fothergill, of* 3, *Central-buildings, Westminster, London, S.W.* 1.

The condensing tubes A are arranged in clusters C, so as to form a number of condensing units which are so arranged within the shell as to provide a space for the flow of steam around each cluster, so that the steam is uniformly distributed to the condensing surface throughout the condenser. Each tube cluster C has an off-take D, through which the uncondensed gases and any remaining vapour is withdrawn from the tube clusters into the vacuum or suction chamber E, which is connected by the

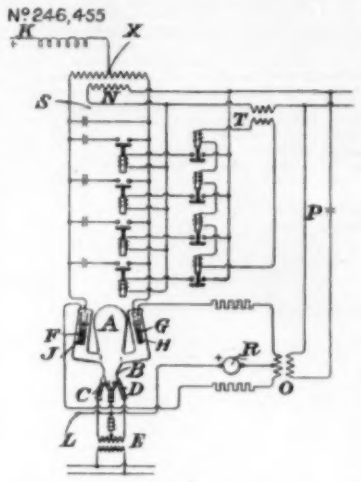


branch F to a suitable air-extracting device. The air off-takes D may be of any convenient form, and in the arrangements shown they are provided with inlet ports in the condensing chamber throughout the length of the water tubes A, so as to produce a uniform air suction effect, and a large perforation or port leading from each off-take into the vacuum or suction chamber E. The cooling water is circulated through the water heads H and the tubes A in any convenient manner, the exhaust steam entering the inlet L and the condensate being removed from the outlets M. Condensate formed in the air suction chamber E can be removed by means of the outlet N.—*April 6th*, 1926.

ELECTRICAL APPLIANCES.

246,455. January 5th, 1926.—IMPROVEMENTS IN AND RELATING TO SYSTEMS OF ELECTRIC DISTRIBUTION, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.* 2.

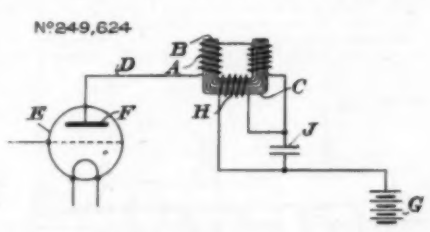
This specification describes a scheme for converting direct current into alternating current by means of an electron discharge device, comprising a main bulb A having at one end a cathode B of mercury and auxiliary anodes C and D, also of mercury on either side of the cathode B. An arc may be maintained between the cathode B and anodes C and D by means of an alternating source of potential E. The bulb A is provided with side arms, within which are working anodes F and G, and controlling grids H and J. Current is supplied from mains K and L through the tube to the primary winding X of the transformer. The secondary winding N of the transformer is connected to a load, not shown. The direct-current main K is connected to the middle point X of the upper transformer winding and the main L is connected to the cathode element of the tube, so that current impulses supplied by the latter flow in opposite directions through winding N. The tube comprises, in effect, two valves, each controlled by means of voltages applied to its grid. The connections for this purpose comprise a transformer O, the primary winding of which is connected across the load circuit through a condenser P. The terminals of the secondary winding of transformer O are connected to the grids H and J through resistances. The mid-point of the



secondary winding is connected to the cathode through a source of energy R, which is arranged to give a negative bias to each grid. A condenser S is connected across winding X. In order, however, that the capacity connected across winding X may vary with the load, a transformer T is associated with the output circuit, so that the current induced in the secondary winding of the transformer will be proportional to the load current. Relays are connected to the terminals of the secondary winding of transformer T, and are arranged to be operated in response to certain current values. Each relay controls an associated switch, which, in turn, connects a condenser across the primary winding X.—*April 8th*, 1926.

249,624. January 19th, 1925.—ELECTRO-MAGNETIC SOUND PRODUCERS. Fuller's United Electric Works, Ltd., Groveroad, Chadwell Heath, and A. P. Welch, 33, Eastwood-road Goodmayes, Essex.

This invention relates to telephone circuits of the loud-speaking type, and is intended to eliminate the expenditure of power commonly entailed by the maintenance of an electro-magnetic field, or, alternatively, the provision of a powerful permanent magnet. The telephone coils A which carry the signal current are wound on the pole pieces B in the ordinary way, and the permanent magnet is replaced by a soft iron yoke C. The steady plate current in the anode circuit D of the last valve E is made to provide a suitable magnetic field, and on this field

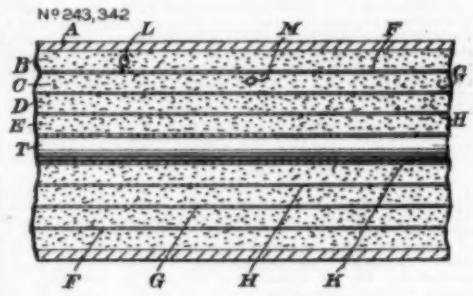


is superimposed the changing field due to the variation of the telephone currents at speech frequencies. In the arrangement shown the coils A are connected in series between the anode F and the positive terminal of the high-tension battery G. The soft iron yoke C is, however, provided with an additional winding H, connected in series with the two telephone coils A, the winding on the yoke C being shunted by a condenser J. Thus the steady plate current flowing through the yoke coil H provides the main excitation, the signal currents being by-passed through the condenser J. The main effects of these signal currents is therefore produced by the telephone coils A. The yoke coil H may be so connected as either to assist or to oppose the current flowing in the telephone coils A as desired.—*April 1st*, 1926.

TRANSMISSION OF POWER.

243,342. November 12th, 1925.—IMPROVEMENTS IN HIGH-TENSION CABLES, Max Sieverts Fabriks Aktiebolag, of Sundbyberg, near Stockholm, Sweden.

The cable described in this specification is designed to prevent a breakdown of the insulating layer. A is the lead sheath and B, C, D and E the several layers of insulating material, whilst

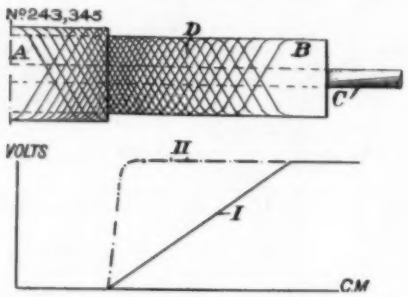


F, G and H are equalising layers placed between the former and the central conductor T. If the outside insulating layer B has a defective point L, the tension will increase at that point, but, on the other hand, the equalising layer F tends to reduce the tension and equalise it, thereby reducing the danger of breakdown. In the same manner, the increase of tension due to a

weak point M in the insulating layer C will be equalised. If the points L and M should be punctured, the punctures will be prevented from combining, owing to the relatively high electric insulating power of the equalising layer F, preventing the voltage drop produced at the point L from being transmitted to the point M, which is supposed to be located at an axial distance from the point L at least equal to the probable axial minimum distance previously indicated between adjacent weakened joints in the insulating layers B and C.—*April 8th*, 1926.

243,345. November 13th, 1925.—IMPROVEMENTS IN OR RELATING TO HIGH-TENSION CABLES, Max Sieverts Fabriks Aktiebolag, of Sundbyberg, near Stockholm, Sweden.

This invention relates to an arrangement by which it is possible to join high-tension cables by means of common cable junction-boxes, using cable ends, the insulation of which is removed only on a relatively short length. A is the cable sheathing, B the dismantled part of the insulation and C the conductor. Round the insulation next to the edge of the sheathing there is a braiding D consisting of a bad conducting wire material or taping. The specific dielectric conductivity should be greater than that of the insulating material. This braiding is applied in a quantity or thickness decreasing towards the bare conductor, so that the

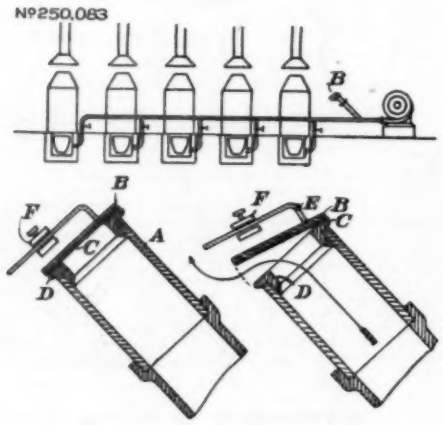


voltage drop between the sheath and the insulation is distributed along a relatively considerable length, in order that the voltage drop per unit of length will be relatively small, and below the value which permits partial discharges to take place. The course of the voltage drop is indicated by the curve I. The dotted curve II, on the other hand, shows the voltage drop without the arrangement according to the invention, this curve showing that the voltage drop per unit of length in the proximity of the lead sheath is greater than in the case illustrated by the curve I. As a material suitable for the tension equalising braiding D, asbestos in the shape of wire or tape may be wrapped round the cable and decreasing in quantity in the direction of the bare conductor.—*April 8th*, 1926.

MISCELLANEOUS.

250,083. July 31st, 1925.—AUTOMATIC NON-RETURN REGULATING FLAP FOR THE CONDUITS FOR THE ADMISSION OF AIR TO SMELTING FURNACES, August Köbele, of No. 21, Jagdhausstrasse, Oosscheuern, near Baden-Baden, Germany.

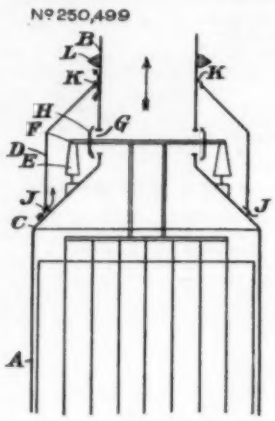
This invention relates to devices for regulating blast-pressure in smelting furnaces, and has for its object to provide an improved construction of a pressure release valve of the type adapted to open automatically when the blast-pressure becomes excessive, owing to a sudden decrease of the load on the blower or other cause. If the air admission is shut off, for instance, for two smelting furnaces, the admission of air or oxygen to the other smelting furnaces is instantaneously increased as the



centrifugal blower, after the partly shutting off of the air admission, continues to revolve at the same speed as at full activity. The reaction thus produced raises a hinged flap B mounted on the open end of an outlet tube A, whereby increased admission of oxygen to the smelting surfaces which are still working, and consequently excessive heating of the furnaces and explosion of the gases from combustion are prevented. Owing to the inclined position of the tubular exhaust A, the hinged flap B is always in contact with the outer edge of the exhaust tube A. Packing is provided by means of a leather disc C and an accurately fitting seating ring D. A counterweight F, slidably mounted upon a bar E on the flap B, serves accurately to regulate the pressure at which the flap B is raised.—*April 8th*, 1926.

250,499. December 17th, 1925.—METHOD OF AND APPARATUS FOR CONTINUOUSLY CLEANING INSULATORS USED IN ELECTRICAL GAS CLEANING AND DUST-PRECIPITATING INSTALLATIONS, *Lodge-Cottrell, Ltd., of 51, Great Charles-street, and Church-street, Birmingham.*

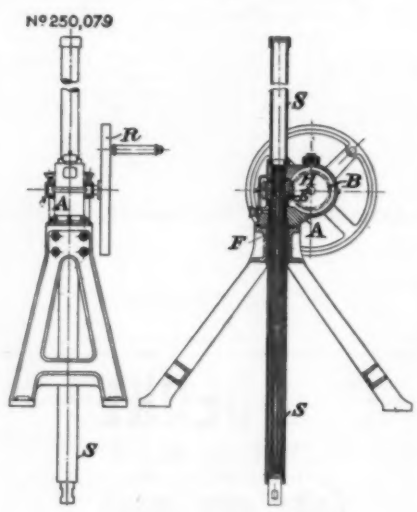
The hot gases to be cleaned flow through the electrical precipitator A and the cleaned gases escape through the conduit B. The cross section of the gas passage diminishes from the precipitating chamber A to the conduit B. On the sloping surface C, formed by this narrowing of the gas passage, there is an insulator chamber D, the sloping roof of which reaches to the conduit B. On the high-tension insulator E, carried on the sloping surface C, inside the chamber D, there is a bearer F supporting the electrodes. The opening G in the wall of the conduit B, for the high-tension lead, is protected on the side adjacent to the insulator by a shield H. The chamber D is provided at the bottom with an inlet opening J, on the sloping surface C, and in the roof close to the wall of the conduit B with an outlet K. These openings J and K are for the passage of the current of air, which is the cleaning medium for the insulator. A projection L is arranged on the wall above the outlet K and serves to protect the outlet K from the weather. The heating of the chamber D by means of the walls of the precipitator or conduit causes an upward motion of air through the chamber from J to K. The current of air thus produced, passing over the surface



of the insulator keeps it clean, and at the same time, on account of the temperature, prevents moisture condensing thereon. The shield H protects the insulator from gases entering the chamber from the precipitator A or the conduit B, by deflecting them into the upward current of air flowing through the chamber.—*April 15th*, 1926.

250,079. July 23rd, 1925.—SLUICE OPERATING GEAR, Urquhart Lindsay and Robertson Orchar, Ltd., and James Keith Anderson, all of Blackness Foundry, Dundee.

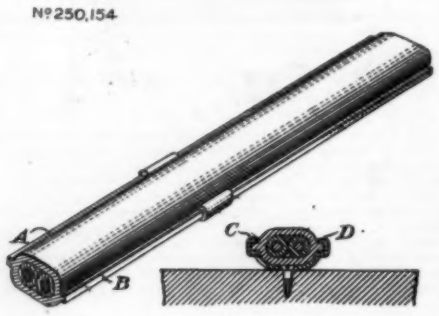
On the top of the frame there is a cast iron gear case A containing the operating gear comprising the worm B and the pinion E, which engages with a threaded rod F to which the sluice or shutter is connected. The worm B is fixed and keyed on to a spindle H, on which there is a hand wheel R. The threaded rod



F is prevented from turning by a feather key which is fitted and fixed into a slot in the gear case, and which also fits a keyseat or groove cut in the body of the threaded rod F. Pipes S are screwed into the top and bottom of the gear case and serve for enclosing the threaded rod F. The lower end of the rod F is fitted with leather washers which fit the bore of the encasing pipe, for the purpose of retaining the grease necessary for the screw thread, and to prevent the ingress of liquids.—*April 8th*, 1926.

250,154. May 14th, 1925.—IMPROVEMENTS IN ELECTRIC CABLES, Fuller's United Electric Works, Ltd., of Woodland Works, Grove-road, Chadwell Heath, and Archibald Parker Welch, of 33, Eastwood-road, Goodmayes.

An electric cable is provided in accordance with this inven-



tion, with ribs A and B on its side, for the purpose of fixing the cable, and, as shown in the lower illustration, the ribs fit into clips, which are screwed to the wall or other support, the clips being simply pinched up with pliers at the points C and D.—*April 8th*, 1926.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—The Institution of Electrical Engineers asks us to announce that it has decided, on account of the strike and in view of the coal situation, to postpone to next year—June 14th to 17th, 1927—the summer meeting at the North-Eastern Centre, which was to have been held next month.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

CHEMICAL ENGINEERING GROUP.—Abbey House, Westminster, London, S.W. 1. Annual general meeting. 6 p.m.

INSTITUTION OF PRODUCTION ENGINEERS.—Society of Motor Manufacturers and Traders, 83, Pall Mall, London, S.W. 1. Paper, "Inspection Methods," by Mr. A. Butler. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "Aims and Methods of Therapeutic Research," by Sir Almroth Wright. 9 p.m.

MONDAY, MAY 31ST.

SURVEYORS' INSTITUTION.—12, Great George-street, London, S.W. 1. Annual general meeting. 5 p.m.

TUESDAY, JUNE 1ST.

ILLUMINATING ENGINEERING SOCIETY.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Discussion on "Research in Illumination," opened by Mr. J. W. T. Walsh. 7 p.m.

SOCIETY OF GLASS TECHNOLOGY.—University College, Gower-street, London, W.C. 1. Demonstration and lecture, "Glass in Early Ages," by Sir W. M. Flinders Petrie. 2.30 p.m. Annual dinner at the Hotel Cecil, Strand, W.C. 2. 7 for 7.15 p.m.

WEDNESDAY, JUNE 2ND.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. Wireless Section meeting. "Low Frequency Intervalve Transformers," by Mr. P. W. Willans. 6 p.m.

SOCIETY OF GLASS TECHNOLOGY.—Research Laboratories of the General Electric Company, Ltd., Wembley. Papers: "Opal Glass," by Mr. J. W. Ryde; "The Electrical Conductivity of Glass at High Temperatures," by Mr. F. F. S. Bryson; "The Influence of Moisture on the Rate of Melting and on the Properties of Soda-lime-silica Glasses," by Edith M. Firth, Mr. F. W. Hodkin, Mr. Michael Parkin, and Professor W. E. S. Turner; "The Physical Properties of Zinc Oxide Containing Glasses," by Dr. S. English and Professor W. E. S. Turner. 2.30 p.m. Visit to Osram G.E.C. Glass Works at Wembley. 10.15 a.m.

THURSDAY, JUNE 3RD.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "Iron in Antiquity," by Dr. J. Newton Friend. 5.15 p.m.

THURSDAY AND FRIDAY, JUNE 3RD AND 4TH.

IRON AND STEEL INSTITUTE.—Institution of Civil Engineers, Great George street, London, S.W. 1. Annual meetings, deferred from May 6th and 7th, on account of the general strike. For programme see page 447. 10 a.m. each day. Annual dinner at the Connaught Rooms, Great Queen-street, W.C. 2, on Thursday, June 3rd, at 7.30 p.m.

FRIDAY, JUNE 4TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Shire Hall, Nottingham. East Midland District meeting. 2.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "Researches in Palestine," by Professor John Garstang. 9 p.m.

SATURDAY, JUNE 5TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South-Eastern District meeting at Richmond and Chertsey. 11 a.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South Midland District meeting at Bushey. 10.45 a.m.

WEDNESDAY, JUNE 9TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—North-Western District meeting at Blackburn. 10.45 a.m.

WEDNESDAY TO SATURDAY, JUNE 9TH TO 12TH.

INSTITUTION OF WATER ENGINEERS.—Summer meeting in Manchester. For programme see page 450.

SATURDAY, JUNE 12TH.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Visit to Nottingham and works on the river Trent. 1 p.m.

CONTRACTS.

THE CLYDE CRANE AND ENGINEERING COMPANY, Ltd., of Mossend, Lanarkshire, informs us that it has received an extensive order from the South African Railways for the supply of its patented level-luffing harbour cranes.

THE WOODALL DUCKHAM VERTICAL RETORT AND OVEN CONSTRUCTION COMPANY (1920), Ltd., has received from the directors of the Deal and Walmer Gas Company an order for the supply of an installation of continuously working vertical retorts having a carbonising capacity of 40 tons per day. The installation will be complete with the necessary coal and coke-handling plant, coke storage hoppers and screen and waste heat boiler.

THE LYALL CONSTRUCTION COMPANY has, it is reported from Ottawa, been awarded the contract for the steel gates of the Welland Canal. There are more than thirty of these gates to be supplied, and the total cost will be in the vicinity of 4,500,000 dollars. The order will call for the awarding of contracts for 20,000 tons of metal construction, of which 16,000 tons will be steel and 4000 tons castings. It will require three or four years to complete the work.

ED. BENNIS AND CO., Ltd., of 28, Victoria-street, Westminster, London, S.W. 1, inform us that they have just received from the Austin Motor Company, Ltd., Longbridge Works, Northfield, Birmingham, an order to equip eleven 8ft. 6in. diameter Lancashire boilers with their "Sprinkler" pattern stokers and self-cleaning compressed air furnaces with three-speed independent drives for the stoker boxes and furnace bars. This order follows on the fitting of a trial set of stokers a few months ago.